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A BIOLOGICAL MEASUREMENT OF RADIUM GAMMA RAYS

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ATTEMPTS to express gamma-ray dosage in terms of the roentgen have thus far yielded discordant results. Some investigators have approached the problem by endeavoring to determine the ionizing effect of the gamma rays in air. Direct measurement of this effect by means of the standard open chamber and thin-walled chambers (3, 11) has largely given place to indirect methods, such as calculation from determinations of the total gamma-ray energy per gram of radium; calculation by means of Eve's constant, and the measurement of the ionization produced in a small volume of air enclosed within an irradiated solid, such as a thick-walled thimble-type chamber. Some of these results have been collected by Sievert (17) and Friedrich (4). The numbers of roentgens corresponding to one milligram-hour of radium obtained in these various ways differ greatly among themselves. The open chamber gives values in the neighborhood of 2–3, while indirect methods give values between 8 and 11 r/mgm.-hr. The values given by open chambers have been shown to be too low (1, 11) for a reason which will be mentioned later.

All the figures that have been mentioned refer to the intensity of radiation, filtered through 0.5 mm. of platinum, at a distance of 1.0 cm. from a point source. The results obtained in experiments in which different filtrations and distances are used are customarily reduced to these or other standard conditions, for without such reduction they cannot be compared with each other.

In addition to these methods involving the ionization of air, mention should be made of an interesting procedure recently reported by Taylor and Mohler for determining the total ionization produced by absorption of radiation in a liquid. A preliminary value of 6.9 r/mgm.-hr. has been obtained by this method (19).

A biological method of approaching the problem involves a comparison of the magnitude of the reaction produced by both gamma rays and x-rays in a living test object. When the effect of a dose of gamma rays is the same as that brought about by a measured dose of x-rays, the two doses have been assumed to be equal (2). In order to avoid the assumption that the roentgen thus determined biologically is actually the same as that defined in terms of ionization, it is convenient to agree that a dose of gamma radiation which produces the same amount of biological effect as one roentgen of x-radiation shall be called, as Failla suggests, an "equivalent roentgen" or, as possibly more descriptive, a "biological roentgen." The values that have been obtained by biological methods, when reduced to standard conditions, range from 4 to 6 r/mgm.-hr. (2, 8, 13, 16, also data in 7 and 18 reduced to comparable form by the present writers). These results are in

fair agreement among themselves, but they do not agree with those obtained by physical methods. If it were assumed that both sets of values are substantially correct, the conclusion might be drawn that equal doses of x- and gamma rays, measured by their ionization, produce different quantitative effects. Before considering such a conclusion we should discuss in more detail the conditions under which the biological measurements were made, and whether the physical methods have correctly measured air ionization. The latter question will be briefly considered in our concluding discussion.

The difficulties encountered in measuring gamma rays by physical methods have been dealt with by many authors and will not now be discussed except in relation to the biological measurements. On the other hand, little has been said in the literature regarding the choice of suitable physical conditions for exposing small test objects such as *Ascaris* or *Drosophila* eggs to gamma rays.

It may be worth while in passing to re-emphasize the importance of keeping clearly in mind the limited though fundamental significance of the type of experiment under discussion, in relation to the larger problem of irradiation under deep therapy conditions. In the experiments considered in the present article the object is to study the biological effect of x-rays or gamma rays in relation to other information about the *absorbed* radiation. For this purpose the experiment is simplified by allowing the test object to absorb energy, so far as possible, from only the direct rays emerging through the filter, avoiding absorption of radiation of uncertain amount and quality scattered by extraneous objects. Under these conditions, by means of known absorption data the absorbed energy and hence the biological effect can be related to the intensity and quality of the incident radiation. In marked contrast to this simplified experimental procedure is the irradiation of tissues under deep therapy conditions. In the latter case there is no simple relation between the amount and wave length of the absorbed radiation and the rays incident on the extended absorbing and scattering medium in which the tissue is located. The question of this latter relation in any particular case must be answered before the results of the former type of experiment can be applied. Lauritsen has called attention (10) to the confusion which has arisen in certain cases in which statements about the relation of biological effect to the wave length of the *absorbed* radiation have been misapplied to questions involving the influence of the wave length of the *incident* radiation on the transmission of the energy through an extended medium.

EXPOSURE CONDITIONS FOR SMALL TEST OBJECTS

Source and Filter.—In experiments of this type the radiation has usually been obtained from an extended source with dimensions comparable to the distance between the source and the test object. Under these conditions it may be difficult to take accurate account of the variable distance and filtration applying to the test material for rays coming from different parts of the source. The early radium measurements by one of the present authors were affected by this source of uncertainty (16). This difficulty can be avoided in large measure by the use of a spherical filter and applicator enclosing at its center a small bulb of radon which acts as a point source.

Scattered Radiation.—Another matter to be considered in planning exposure conditions is the effect of scattered gamma radiation.

The thin filters used in biological experiments absorb only a small fraction of the total radiation from the source and so scatter a still smaller fraction (less than 10 per cent for 1 mm. platinum). The effect of this scattered radiation on the test object is always included with the direct rays as part of the effect to be measured. The amount of this scattering which reaches the test object depends on the

geometrical arrangement of source, filter, and test object. However, with arrangements suitable for the present type of experiment, variations on this account are small enough to be unimportant unless the precision of the experiment approaches 1 per cent as in the present investigation. The use of a small spherical filter puts this factor under definite control.

A lead or platinum filter also emits a certain amount of fluorescent radiation, but this can be shown by calculation to be responsible for less than 1 per cent of the energy absorbed by a test object composed of light material.

The effect of scattering by objects other than the filter should be reduced to a negligible amount in experiments of the present type. Rather than attempt an exact calculation of the scatter from surrounding objects with the arrangement used, it is simpler to adopt conditions such that an upper limit small enough to be neglected can be calculated on simplified assumptions such as isotropic scattering without change in wave length. A picturesque way of delimiting a danger zone to be kept clear of substantial scattering objects, with a large factor of safety, is to imagine the radio-active material from the source to be transferred to a point on a spherical surface drawn around the test object. By inverse square law a radius for this spherical surface can be specified such that the intensity at the test object will be any desired fraction of the intensity when the radio-active material is in its proper position. This fraction will certainly be much greater than the effect, on a test object composed of light material, of back-scattering by all matter more remote than the distance thus specified. For example, if the test object is 1 cm. from a point source, the effect of radiation scattered from all objects over 10 cm. away will be less than 1 per cent of the effect of the direct rays.

Secondary Beta Radiation.—Of greater importance are the effects connected with the long range of the secondary beta radiation. It has been mentioned that in comparing the results of exposure of different test objects to gamma rays, the various conditions of irradiation are usually reduced to standard conditions. This is done by applying both the inverse square law of distance from a point source, and data expressing the absorption of gamma rays in the intervening material. This procedure involves the tacit assumption that the effect produced in a cell is determined by the flux density of gamma radiation in the region occupied by that cell. But actually, the effect on the cell under consideration is determined by the flux of gamma radiation not only through the cell but also through a region surrounding the cell to a distance of millimeters in tissue, or of meters in air. The reason for this is that the biological response depends, not on the gamma rays directly, but on the long range secondary beta particles produced when gamma radiation is absorbed. This situation is very different from that which obtains when low voltage x-rays are used. In the latter case the ionizing secondary electrons or beta particles produced in a cell have a range which may be small compared to the diameter of the cell. Therefore secondary betas produced outside will not be able to enter the cell and the observed effect is almost entirely due to secondary betas which originate within the cell itself. Consequently the presence or absence of small amounts of material, such as a celluloid plate or strip of gauze used to support the cell during exposure, is unimportant. In the case of low voltage x-radiation, therefore, it is justifiable to relate the observed result to the x-ray energy absorbed in the cell itself.

It is evident from what has been said that a mere statement of filtration and distance from a point source is not sufficient to determine unambiguously the beta-ray activity produced in a test object by gamma radiation. Strictly speaking, a complete description of the distribution and composition of all material in the neighborhood from which beta particles can pass to the test object is needed. The obvious way to avoid most of the diffi-

culties resulting from this situation is to immediately surround the test object with a layer of tissue-like material which is thick enough so that the "active region" contributing beta particles in appreciable amount to the test object is restricted to this envelope, whose properties can readily be specified. In this way the complicated process of conversion of gamma rays to beta particles, insofar as it affects the cell, is confined to a limited region such that the beta-ray activity produced in the cell will depend on the gamma radiation which is absorbed within this region only.

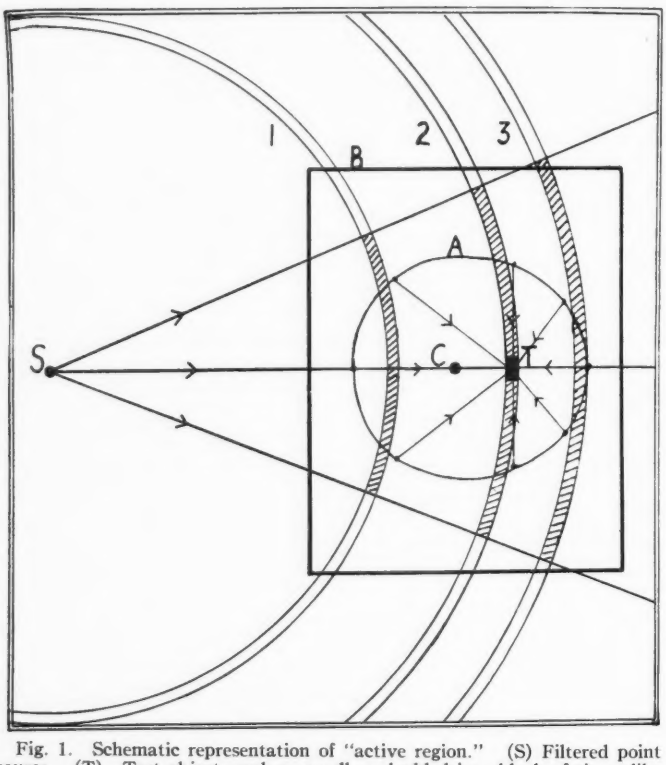

Fig. 1. Schematic representation of "active region." (S) Filtered point source. (T) Test object, such as a cell, embedded in a block of tissue-like material with boundary B. (A) Boundary of "active region" such that no appreciable amount of secondary beta radiation can reach T from points outside this boundary. (C) "Center of absorption" with respect to beta production in T.

Figure 1 shows schematically such an "active region" surrounding a test object, T. The unsymmetrical configuration about the test object is a consequence of the predominantly forward direction in which the beta-ray energy is emitted. At first sight it might seem, since most of the beta particles arriving at the test object are produced in the side of the active region toward the source, that the beta activity at the test object would be a measure of the gamma-ray intensity at some other point, C, which might be called the "center of absorption" of the active region. But since most of the beta particles are moving in the forward direction it is approximately correct to regard the flux of beta radiation which accompanies the gamma-ray beam as diverging from the source along with the gamma flux. Thus the beta rays produced in Zone 1 (Fig. 1) by gamma rays of intensity I_1 will have spread out in passing to Zone 2 to correspond to gamma intensity I_2 at this

position. However, the lateral compensation which was effective in this case will not suffice to bring about a radial concentration of the backward moving betas produced in Zone 3 into Zone 2. This would require a mechanism analogous to specular reflection. But in view of the small proportion of backward moving betas and the small radial distance involved, their disturbing influence on the divergence of the beta flux may be neglected. Likewise the attenuation of the gamma radiation by absorption in the material lying between the "center of absorption" and the test object, being much less than 1 per cent may be left out of account for practical purposes.

Thus it is seen that if a test object is immediately surrounded by a layer of similar material at least as thick as the effective range of secondary betas, the beta activity in the test object due to gamma rays from a point source will be to a sufficient approximation proportional to the flux density of gamma rays at the test object, and will follow the inverse square law of distance from the source.

The condition just described corresponds exactly to the situation of a cell in the body not too near the surface. Therefore, experimental results obtained under such conditions will, in that respect, be applicable for therapeutic purposes.

It is interesting to note some of the errors which have been made when such a simplified beta-ray contributing region has not been used. It has been mentioned that attempts at measuring free air ionization of gamma rays, using open ionization chambers, have given values less than one-third of those obtained by other methods. In this situation the relation between gamma-ray conversion and beta-ray absorption and scattering which result in a certain ratio of beta- to gamma-ray activity in a freely diverging beam, are completely upset by the presence of the diaphragms used to define the narrow beam required in this type of measurement (1, 11), resulting in ionization values one-third to one-fourth as large as those obtained from thimble-type chambers.

It is hardly to be expected that such large differences should be found between the results obtained with any one of the experimental arrangements ordinarily used with living test objects. These objects are always exposed within a very few centimeters of the source of radiation, and there is little or no effective diaphragming. But puzzling complications are likely to occur even when working with undiaphragmed radiations, if the test object is not surrounded with sufficiently thick walls to exclude beta particles originating outside the wall material. By way of illustration, we may compare some measurements by Glasser (5) with those of Workman (20) and Albrecht (1). These latter, using diaphragmed beams and drum-type chambers, found that a wall thickness of about four millimeters of carbon is needed to build up full beta-ray equilibrium. On the other hand, Glasser, using an undiaphragmed radium source with 0.5 mm. platinum filter, exposed, at an unspecified distance, a thimble chamber with walls of variable thickness composed of "Luftmasse." The chamber was mounted on a thick metal stem. He found that with increasing wall thickness, the ionization reached a maximum at 1 mm. and concluded that this thickness is sufficient for an "air wall" chamber. On the other hand, Friedrich, Zimmer and Schulze (4), also using a thimble-type chamber, but avoiding the effect of secondary beta radiations from the filter, found that ionization increased with wall thickness up to 4 mm. of carbon. In agreement with Albrecht and Workman, these latter workers found a deficiency of the order of 30 per cent for a 1 mm. carbon wall. Since the equilibrium beta-ray emission from platinum is about 25 per cent less than for carbon (for low gamma-ray filtration), one might thus expect an increase of the order of 6 per cent in going from 1 mm. to 4 mm. under Glasser's conditions. Presumably this was masked by some unrecognized compensating effect. In this connection it is

noteworthy that the ratio of 1 per mg.-hr. obtained by Glasser and Mautz, using 0.5 mm. Pt filter, is 7 per cent larger than that of Glasser and Seitz who used 2.0 mm. of brass (5). The fact that the ionization produced in their chambers was partly due to secondary beta rays originating in the filters might well explain this difference. With lightly filtered gamma radiation, the secondary beta emission in the forward direction is greater for heavy elements such as platinum than for materials of medium atomic number, such as brass. This is due to the additional photoelectric absorption of the gamma rays in heavy elements which more than compensates for their stronger nuclear scattering of beta particles. This difference amounts to some 15 per cent (20).

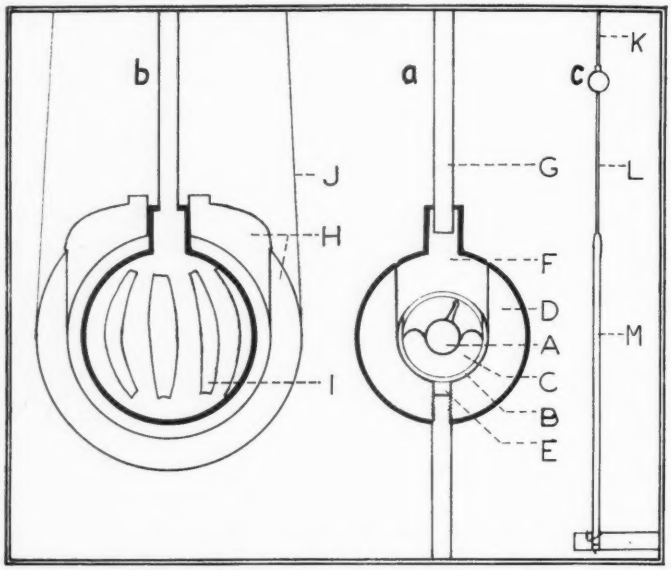

Fig. 2. Spherical applicator. 2-*a*. (A) Spherical glass bulb 3.5 mm. in diameter containing radon. The seal-off tip is shown projecting upward. (B) Spherical filter of platinum-iridium 0.5 mm. thick, 9.2 mm. outside diameter, consisting of two closely fitting sections machined from solid bar. (C) Paraffin with a central cavity to hold the radon bulb. (D) Sphere, 18.7 mm. in diameter, machined from black bakelite and fiber composition, density 1.30 gm./cm^3. The wall is 4.7 mm. thick. A threaded hole, E, receives a wooden splint 2 mm. in diameter for handling and supporting the sphere. The material was found by a competent analyst to contain hydrogen 6.7 per cent, carbon 62.0 per cent, remainder oxygen 31 per cent, residue after combustion in oxygen 0.33 per cent composed chiefly of iron oxide. (F) Bakelite plug to which the upper section of the platinum sphere is attached with cement. The plug and platinum sphere can thus be lifted bodily out of D by means of the wooden splint, G.

Fig. 2-*b*. (H) Shell 3.5 mm. thick and 22 mm. inside diameter enclosing the bakelite sphere described under Fig. 2-*a*. The shell is made of the same material as the sphere. (I) Lens-shaped slips of moist filter paper adhering to the sphere and carrying the eggs. (J) Supporting loop of thread.

Fig. 2-*c*. Shows the method of supporting the sphere in the tests in which the outer shell was not used. (K and L) Wooden splints 2 mm. in diameter and 15 cm. long. In the exposures made in the small room L was only 0.3 cm. long. (M) Wooden rod 33 cm. long, 6.5 mm. diameter.

The secondary beta radiations originating in the platinum filter were presumably responsible for a large part of the effect noted by Braun (2) in his measurement of gamma-ray intensity by means of *Ascaris* eggs. Apparently using the experimental arrangement of Zuppinger (21), he placed

a platinum needle on the celluloid plate which carried the eggs. It has been mentioned that the beta emission in the forward direction is greater than platinum than from brass. But also it is some 25 per cent less than from the light elements composing tissue, for which the nuclear scattering effect is small. Hence the eggs should have received a measurably larger effect if the platinum needle had been covered with a few millimeters of light material. In addition to beta rays from the platinum needle, the eggs received beta rays originating in and reflected from the celluloid plate on which they were placed, and from the air, the furniture, and the walls of the room. To interpret fairly the result of such an experiment it would be necessary to evaluate the relative importance of all these contributing effects. On the other hand, in the applicator used by Simon (18) the "active region" surrounding the test material is practically restricted to a layer of hard wood 1 cm. thick. But the large extent of the source in comparison to the effective working distance makes accurate reduction to standard conditions difficult.

These illustrations serve to emphasize the advantage of closely surrounding all test materials used in experiments with gamma rays by a zone of tissue-like material of a thickness at least equal to the effective range of the secondary beta particles. Only under these conditions can the observed effect be directly related to gamma-ray intensity without a careful consideration of the importance of disturbing effects connected with the particular conditions of the experiment. It may be remarked in passing that this requirement is now recognized as essential in the use of small ionization chambers in which the wall effect is utilized (4, 11, 20).

EXPERIMENTAL

Many of the difficulties mentioned in the introduction can be avoided by using an applicator having spherical symmetry. If this has a radius of 1 cm. and a spherical platinum filter 0.5 mm. in thickness, the standard conditions are realized, and the results are obtained directly. Furthermore, by the addition of a close-fitting shell which surrounds the sphere, the simplest possible conditions for gamma-ray conversion are obtained. The test material receives the full beta-ray activity in equilibrium with symmetrically diverging gamma rays in a material which is comparable to tissue.

DESCRIPTION OF APPLICATOR

The applicator consists of a bakelite sphere containing a platinum filter and radon bulb. Its construction is shown in Figure 2; details, including the atomic composition of the bakelite, are given in the caption. The thickness of the bakelite between the filter and the test material is 4.7 mm. According to Workman (20) and Albrecht (1), this thickness is sufficient to ensure that practically all beta radiation which affects the eggs is the result of absorption of gamma rays in the bakelite. It also follows from Workman's results that the 3.5 mm. of bakelite in the shell is sufficient to give the limiting contribution of reflected beta rays. Thus the active region from which beta radiation is received by the eggs is restricted to the adjoining bakelite, the interstice in which the eggs are placed being so thin as to have no appreciable disturbing effect. The radius of the sphere was made somewhat less than 1 cm. to allow for the thickness of the filter paper on which the eggs lie. The diameter of the sphere was accurately determined with a short focus telescope mounted on a calibrated measuring screw, and checked with a micrometer caliper. Slips of filter paper with eggs were then placed on the sphere, as if for an exposure, and the average position of the mid-point of several eggs from the opposite side of the sphere determined by means of the telescope. The diameter of the sphere alone was 18.67 mm. The distance of the mid-point of the eggs above the surface was 0.33 mm. The distance from the center of the sphere to the eggs was thus 9.67 mm., with a probable error of ± 0.03 mm. To

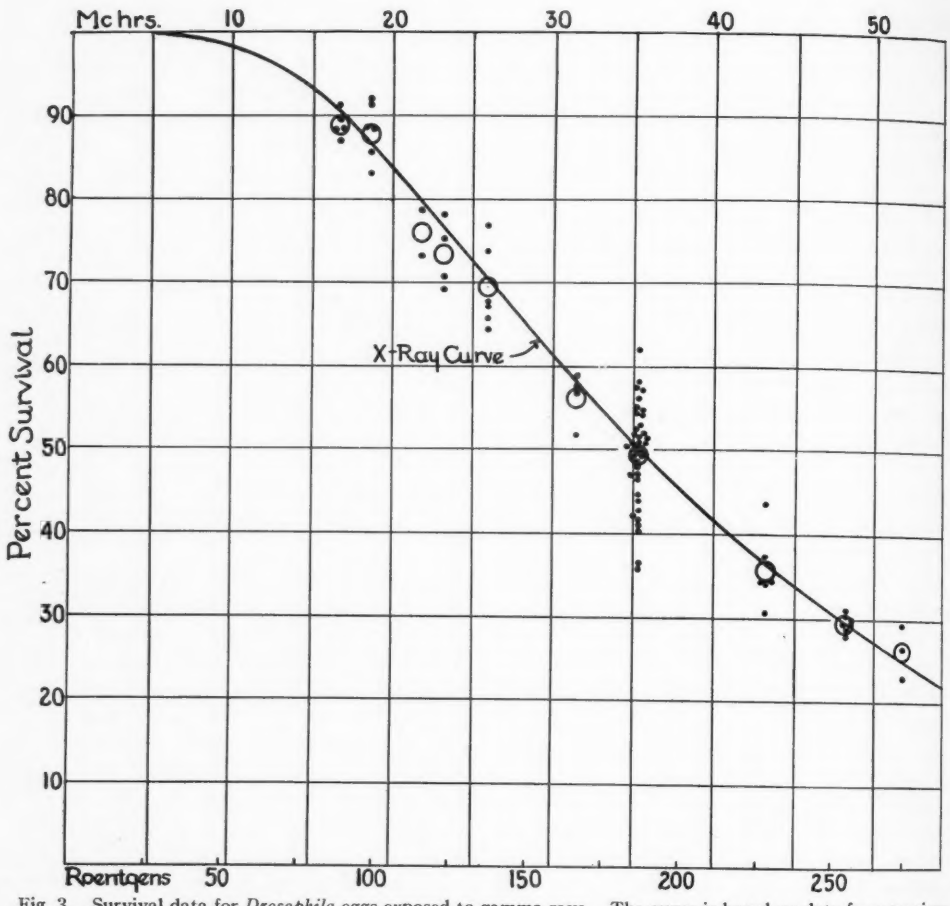

Fig. 3. Survival data for *Drosophila* eggs exposed to gamma rays. The curve is based on data from previous x-ray experiments. The symbols represent the results of the present experiments with gamma rays. The open circles represent the averaged percentage survival of each group of tests; the small solid circles, the percentage survival of individual exposures.

reduce the results to 1 cm. diameter the correction factor is 0.934 ± 0.006.

The small size of the radon bulb in relation to the platinum filter is important. As may be seen in Figure 2 the greatest obliqueness with which a ray can pass through the platinum shell is insufficient to cause any serious difference in filtration. The effect of the average obliqueness will be imperceptible.

THE TEST OBJECT

The eggs of the fruit fly, *Drosophila melanogaster*, were used as a test object in these experiments, for their quantitative response to radiations is more constant than that of any other biological material. A detailed description of the technic involved is published elsewhere (14, 15). The eggs, on slips of black filter paper, are given the desired dose of radiation and then incubated at room temperature (22–25° C.). It should be emphasized that if the results of other experiments are to be compared with these, the exposures should be limited to a duration of not more than 25 minutes, and the intensity should not be less than 5 r/min. On the day following the exposure, those eggs that have already hatched are counted. There are always a few of these which were old when laid, and therefore they should be excluded. On

the next day the samples are counted, and the proportion of survivors determined. The result thus obtained is corrected to allow for the fact that in the control samples some eggs are infertile, or fail to hatch out as larvæ. Since the average fertility of the controls is 97 per cent, the actual percentage of survivors is divided by this amount.

Careful study has demonstrated that there is a definite relation between the dose of x-rays and the proportion of eggs that hatch. A dose of 190 r results in a hatching rate of 50 per cent, regardless of the wave length of the incident beam. The wave lengths thus far tested range from 0.05 to 1.6 Å. (14). The curve shown in Figure 3 indicates the relation between dose and effect as obtained with x-rays. At the bottom of the figure is a scale showing doses in roentgens; the percentage of surviving eggs is seen on the ordinate. By drawing an ordinate up from any point on this scale to meet the curve, the quantitative effect of such a dose can be found. Statistical analysis of data derived from 200 experiments with x-rays shows that the average deviation in the percentage of survival of a single test from the expected point on the curve is 2.54. The standard, or root mean square deviation of a single test, is ± 3.10. When the same carefully measured dose is given to several different lots of eggs, the averaged percentage of survivals lies very close indeed to the curve, the deviations averaging less than 2. These figures are presented in order to demonstrate that results obtained with *Drosophila* eggs are precise when the tests are performed with the proper technic.

The curve shown in Figure 3 is used as a means of measurement. For if the survival rate of the eggs is determined with such precision by the dose, then, conversely, the dose can be determined with equal precision by the survival rate. Data illustrating this point have been presented elsewhere (14, 15) Thus if after irradiation, it is found that 65 per cent of the eggs hatch out as larvæ, the curve indicates that the dose must have been approximately 165 r. In Table I the doses thus measured are called "biological roentgens" to distinguish them from doses measured by a dosimeter.

The eggs were placed on small lens-shaped pieces of black filter paper which when moistened with banana juice, lie smoothly on the surface of the sphere, as shown in Figure 2. Exposure commenced when the plug carrying the radon and filter was inserted into the sphere. In those tests in which the shell surrounded the sphere, all of the eggs received the same dose. The exposure was terminated by withdrawing the radon. In other tests in which the shell was not used, the slips with their eggs were removed, one or more at a time, after the desired exposure, as indicated by a stop-watch, had been given. The temperature during these experiments varied between 22.0 and 24.7° C.

On the first two days of the experiment the sphere, supported as shown in Figure 2-*c*, was mounted on the end of a light board projecting 20 cm. over the edge of a flat-topped wooden desk. The applicator

TABLE I

Without Shell	Dose	Alive	Dead	Percentage Alive	Corr.	Biol. r	r/mc.-hr.
Large room	25.93 mc.-hr.	139	72	65.9	67.9	143	5.51
		124	40	75.6	77.8	120	4.65
		154	76	65.2	67.2	144	5.55
					71.0	136	5.24
Small room		137	82	62.6	64.5	151	5.82
		167	64	71.7	73.9	127	4.96
		112	62	63.8	65.7	148	5.71
					68.0	143	5.51

was 108 cm. above the concrete floor of the room, 135 cm. from a brick wall, and about a meter from wooden partitions, shelves, and tables. In the exposures with the shell the applicator was hung by a thread in the same position. To make sure that the experiment was not affected by the surrounding objects the remaining tests were carried out in a large room cleared of all objects so that the applicator was surrounded in every direction by at least two meters of air except for a concrete beam 160 cm. overhead and a horizontally supported long thin wooden stick on the end of which the applicator support shown in Figure 2-*c* was placed.

The radon was obtained from the Memorial Hospital, New York City, through the courtesy of Dr. G. Failla. A preliminary measurement of its activity permitted the preparation of an exposure time schedule before the experiment began. The results of tests made in previous years with another type of applicator provided a basis for determining the approximate doses in mc.-hr. which should result in survival percentages ranging from 90 to 25. The exposure schedule was adjusted for the decay of the radon before each test. Exposures which varied from 2 to 20 minutes in length were made on five different days.

An accurate measurement of the amount of radon was made after it had decayed to a value comparable to the 50 mg. radium standard used at the Memorial Hospital. From this, the quantity at the beginning of the experiment was found to be 446 mc. The decay constant used in calculating this value is 2.097×10^{-6} sec^{-1}.

All of the data obtained in six tests are given in Table I as an example of the method of calculating the values of r/mc.-hr. In these tests, which were made on three different days, the dose was 25.93 mc.-hr. The numbers of living and dead eggs are shown, with the actual and the corrected percentage of survivors. Under the caption "biological r" appear the number of roentgens which on the curve correspond to each individual survival rate. The ratios of r per mc.-hr., seen in the final column, are obtained by dividing the number of biological roentgens by the dose in mc.-hr. The percentage of eggs surviving in the 76 tests which have been made with the present applicator are shown in Figure 3.

TABLE II

	With Shell	Without Shell
	r/mc.-hr.	r/mc.-hr.
Large room	4.41 5.23 4.75 5.26 4.81 5.46 5.00 5.52 5.03 5.63 5.23 5.83	4.42 5.34 4.53 5.39 4.65 5.46 4.81 5.51 4.96 5.55 5.00 5.57 5.03 5.57 5.09 5.62 5.23 5.62 5.27 5.62 5.32 5.90 5.34
Small room	5.00 5.89 5.21 5.97 5.26 6.00 5.32 6.14 5.32 6.20 5.40 6.60 5.47 6.65 5.66	4.83 5.42 4.89 5.44 4.96 5.46 5.02 5.51 5.04 5.55 5.18 5.71 5.23 5.77 5.26 5.82 5.34 5.85 5.34 5.86 5.36 5.87 5.38 5.96 5.39 6.00
Average	5.49 r/mc.-hr.	5.35 r/mc.-hr.
Stand. dev..	0.530	0.366
P. $E._m$	0.069	0.036
	Total average 5.40 r/mc.-hr.	
	Stand. dev. 0.436	
	P. $E._m$ 0.034	
	Corrected value 5.00 r/mc.-hr.	

RESULTS

In Table II are presented the ratios of r per mc.-hr. obtained in all of the 76 tests. The results of the experiments made with the shell and without it are shown in separate columns. Both sets of data are further subdivided according as the tests were made in the large or in the small room. The averages show that the number of r/mc.-hr. obtained when the eggs are enclosed in the bakelite shell is greater than that obtained when the shell

is absent. The difference amounts to 2 per cent, with a probable error for the difference of 1.5 per cent. Under the conditions of this experiment the effect of the shell should correspond approximately to that of the "back wall" in experiments with a drum-type chamber. Workman (20, Fig. 3), using such a chamber, found an increase of 5 per cent due to the presence of a thick back wall of carbon. The present results, while not definitely indicating an increase with the shell, allow a chance of one in five that an effect of the magnitude found by Workman was present.

Between the mean values obtained in the large and small room the difference is greater, being 6 per cent, with a probable error for the difference of 1 per cent. On a purely statistical basis, such a difference would be regarded as significant, but careful examination of the exposure conditions in the two rooms fails to reveal any experimental basis for the discrepancy. As was explained in the introduction, the scatter from surrounding objects was a small fraction of 1 per cent of the total effect in either case. Therefore, it was decided to regard the observed difference as an unusually large accidental error and to take as the most probable value of the result the unweighted average of all the exposures made in both rooms, with and without the outside shell surrounding the applicator. The total average of all of the experiments indicates that the ratio of r per mc.-hr. is 5.40 when the radiation is a point source, the filter 0.5 mm. of platinum and 4.7 mm. of bakelite, and the distance is 9.67 mm. Multiplying this value by 0.934 to reduce to 1 cm. distance, and further deducting 1 per cent to allow for the true absorption in bakelite, the final value becomes 5.00 r/mc.-hr.

Thus far no mention has been made of the percentages of eggs hatching in the various tests. These are shown in Figure 3. At the top of this figure is a scale of mc.-hr. from which the actual doses given to each group of tests can be determined. It is evident that the averages lie very close to the curve, especially when the group consists of many individual tests. The figure also illustrates the amount of variation which may be expected in experiments carried on under these conditions. These variations are somewhat larger than those met with in x-ray tests, due perhaps to the fact that the centering of the radon bulb may have been inaccurate by as much as 0.3 mm. This might introduce deviations of a maximum of about 6 per cent in the dose received by the individual slips bearing eggs. But since these were always symmetrically placed on the sphere, the final average would not be affected.

The range of variation in the values of r/mc.-hr. obtained in the separate tests is indicated by the standard deviations shown in Table II. When the individual deviations from the average are examined, it is seen that two-thirds of the total are not greater than the standard deviation, while 94 per cent are not greater than twice that amount. Thus the frequency distribution closely follows the normal error curve.

DISCUSSION

The ratio of r per mc.-hr. obtained in the present experiments under specially favorable conditions, lies in the middle of the range of values previously obtained by biological methods,[1] and very much below the values determined by the physical methods which have been mentioned. Before remarking on the significance of this difference, we must comment briefly on these physical measurements.

[1] In an article by den Hoed (7) which has appeared since the completion of the present manuscript, some exposures of *Drosophila* eggs to radium gamma rays and to x-rays are described. In the gamma-ray exposures the eggs were exposed to the excessive secondary beta radiation from the lead filter. This error was to some extent counteracted by the fact that in reckoning the dosage the radium tubes were treated as point sources. Of the four radium exposures only one fell on the portion of the survival curve which is steep enough to be used for comparison. This exposure cannot be compared with our survival curve because the author used eggs with a different average age and, therefore, different sensitivity. But plotting his data for 200 kv. x-rays and comparing the gamma-ray exposure with these gives a value of 5 r/mgm.-hr., in agreement with our result.

It has become almost customary to assume that measurements made with thimble-type ionization chambers having walls of light material of sufficient thickness, represent the ionization that would be produced in free air by gamma radiation. A theoretical discussion by Gray (6) has been regarded as support for such a conclusion. But on the basis of Gray's treatment, chambers of equal volume, and with walls composed of any material in which the photoelectric effect is negligible, should give the same ionization. However, Albrecht (1), measuring ionization in chambers having thick walls of aluminum and of an organic material (cellophane), found that the ionization in aluminum walls was 100 per cent greater than in cellophane. On the other hand, Keller (9), who also used thick-walled chambers, found not more but less ionization with aluminum than with a phenol-formaldehyde resin (*Leukorit*).[2] And even with thick walls of the same material, substantial differences have been obtained, as illustrated by the recent determinations of the r/mg.-hr. ratio in thick-walled carbon chambers by Mayneord and Roberts (11), who found a value of 8.3, and Friedrich, Zimmer, and Schulze (4), who obtained a value of 11.2 r/mc.-hr. It seems likely that the explanation of some of these effects is to be sought in connection with the very rapid increase, with atomic number, of the importance of nuclear scattering of beta particles. In view of such discrepancies, and of the fact that the physical values are all obtained by indirect means, it seems advisable to reserve judgment as to the meaning of the difference between the results obtained by physical and biological methods.

Until the meaning of physical measurements of gamma radiation can be further clarified, it seems reasonable to take the view that the processes which determine the response of the egg to gamma radiation are more nearly representative of the biological processes involved in therapy than is the production of ionization through the wall effect of small chambers.

[2] On the other hand, Murdoch and Stahel (12), in an article which has just appeared, obtain very nearly the same ionization in thick-walled chambers of ebonite, paper, aluminum, and copper. Their value of 8.11 r/mgm.-hr. agrees closely with Mayneord and Roberts.

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SUMMARY

Some of the conditions leading to uncertainty in the interpretation of the results of the biological measurement of gamma-ray intensity are analyzed. An applicator designed to avoid these conditions is described. Using *Drosophila* eggs as a test object, the number of "equivalent" or "biological" roentgens per mc.-hr. is measured at a distance of 1 cm. from a point source, with 0.5 mm. platinum filter. The value obtained was 5.00 r/mc.-hr. This result is to be compared with values ranging from 8 to 11, obtained by indirect physical methods.

REFERENCES

(1) Albrecht, E.: Strahlentherapie, 1931, **42**, 328; 1932, **45**, 365.
(2) Braun, R.: Strahlentherapie, 1930, **38**, 11.
(3) Failla, G., and Henshaw, P. S.: Radiology, 1931, **17**, 1.
(4) Friedrich, W., Zimmer, K., and Schulze, R.: Strahlentherapie, 1934, **51**, 18.
(5) Glasser, O.: Strahlentherapie, 1935, **52**, 137.
(6) Gray, L. H.: Roy. Soc. Proc., 1929, **122A**, 647.
(7) den Hoed, D.: Radiology, 1935, **25**, 57.
(8) Holthusen, H., and Hamann, A.: Strahlentherapie, 1932, **43**, 667.
(9) Keller, F.: Strahlentherapie, 1935, **52**, 403.
(10) Lauritsen, C. C.: Am. Jour. Roentgenol. and Rad. Ther., 1935, **33**, 235.
(11) Mayneord, W. V., and Roberts, J. E.: British Jour. Radiol., 1934, **7**, 158.
(12) Murdoch, J., and Stahel, E.: Strahlentherapie, 1935, **53**, 102.
(13) Quimby, E. H. (quoting P. S. Henshaw): Radiology, 1935, **25**, 204.
(14) Packard, C.: Am. Jour. Cancer, 1932, **16**, 1257.
(15) Idem: Radiology, 1935, **25**, 223.
(16) Idem: Jour. Cancer Research, 1928, **12**, 60.
(17) Sievert, R. M.: Acta Radiologica, 1934, **15**, 193.
(18) Simon, S.: Jour. belge de Radiol., 1931, **7**, 285.
(19) Taylor, L. S., and Mohler, F. L.: Science, 1935, **81**, 318.
(20) Workman, E. J.: Phys. Rev., 1933, **43**, 859.
(21) Zuppinger, A.: Strahlentherapie, 1928, **28**, 758.

RADIOTHERAPY OF SARCOMA OF THE SOFT PARTS

(ON THE BASIS OF STATISTICAL ANALYSIS)

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NO OTHER group of tumors includes tissues as widely divergent in their radiosensitivity as the sarcoma group. With the highly radiosensitive lymphosarcoma at one extreme and the radioresistant sclerosing osteosarcoma at the other, one may arrange on the basis of degree of radiosensitivity a scale of the sarcomas which would be nearly as extensive as the scale of radiosensitivity of neoplastic tissues as a whole. This behavior is a natural sequence of the morphologic and especially histogenic characteristics. For, although the general term of "sarcoma" implies pathologically a malignant tumor composed of cells of the connective tissue type and thus in appearance a rather uniform group of tumors, when further elucidation of the nature or origin of the cells is attempted, the variation is found to be exceedingly great. Since the effect of radiation, in a general way, depends on the susceptibility of the cells or tissues irradiated, and since this function, in turn, is the result of many criteria intimately associated with morphologic and histogenic characteristics, obviously the wide difference in type and origin of the cells leads, with some exceptions, to a like difference of radiosensitivity.

The great radiobiologic and pathologic variation has induced not a few of the investigators to suggest the elimination of the term of "sarcoma," and the separation of the tumors included under its heading into distinct entities of their own. Although such a position cannot be claimed to contribute, for the present, very considerably to the clarification of the problem as a whole, nevertheless it clearly indicates the necessity of dividing the sarcomas into subgroups which would permit a better insight into the more or less specific characteristics by paying due regard to the clinical course at the same time. For this reason, it is proposed that in the following the subject of radiation therapy in sarcoma be treated along identical lines, that is, by discussing the various types of sarcomas, which might constitute a subgroup, individually. There are especially two practical advantages which result from such a procedure: *first*, the technic of irradiation (method, dose, fractionation, etc.) can be considered on the basis of radiosensitivity of each particular type of tumor, and *secondly*, the extent of irradiation can be determined by the known clinical course (extension, metastases) of that specific lesion.

Although the title of the paper suggests that every form of sarcoma, except sarcoma originating from the bone, is considered in the discussion, the subgroups of lymphosarcoma, melanosarcoma, and gliosarcoma were likewise omitted, for they represent such distinct processes that they may best be dealt with separately (7, 13).

STATISTICS

A review of the literature concerning the five-year cure of sarcoma in general reveals the not altogether surprising fact that the problem of radiation therapy still forms a rather favored subject of speculative argumentation. Comprehensive statistical publications are few and because of the indecisiveness as to what really should be included in the group of sarcoma, they are somewhat confused and even contradictory. Thus Rostock (19), in 1928, by collecting 505 cases from eight sources, found that although 78 per cent of the sarcomas responded more or less favorably immediately following radiation, the number of permanent cures was exceedingly small, amounting to only 2.9 per cent, whereas the purely surgical statistics of Küttner (cited by Rostock), referring to

some 550 cases, indicate a five-year cure of 30 per cent. This, then, would be *prima facie* evidence that surgical intervention must constitute the method of choice in the treatment of all sarcomas and irradiation reserved for the inoperable cases and perhaps prophylactically for some of the more malignant forms operated upon. In his own series of 119 cases, Rostock (19) obtained a 6 per cent cure in the inoperable group (35 cases) treated by radiation alone, a 10.5 per cent cure in the borderline group (38 cases) treated by incomplete surgical removal and postoperative irradiation, and a 37 per cent cure in the operable group (46 cases) treated by radical extirpation and prophylactic irradiation, a fact which would serve only further to confirm the soundness of the above principle. Yet, by analyzing other statistics, we find that there is a very great discrepancy in the percentage of end-results, even by using an association of surgery and irradiation in all instances. Meves (15), for example, in 1931, by reviewing a total of 173 cases, treated between 1914 and 1928, found only 19 cases (11 per cent) which were permanently cured, and even these were mostly mixed tumors and rarely pure sarcomas. He, therefore, makes the statement that a permanent healing of a sarcoma, although possible, must be considered a rarity. de Waard (6) likewise obtained only a 14 per cent cure in 74 cases of operable sarcoma which were treated by surgery alone. Wollner (27) published, in 1926, 12.8 per cent cures in 39 cases of more advanced sarcomas treated by surgery and irradiation, and 28.5 per cent cures in 21 early cases subjected only to radical extirpation. In contradistinction to this, very good results were claimed by Wintz (26) and Hintze (10). The former indicates a percentage of 35 of five-year cures in a total of 367 cases of sarcoma, whereas the results of Hintze, who, in 1930, reviewed a total of 678 cases treated five years or longer before are as follows: (I) of 216 cases treated by surgery alone, 28.7 per cent cures; (II) of 179 cases of recurrence irradiated, 39 per cent cures; (III) of 82 cases treated by surgery and prophylactic irradiation, 39 per cent cures, and (IV) of 201 mostly inoperable cases treated by irradiation alone, 24.9 per cent cures. A closer scrutiny of these two latter statistics, however, reveals that several types of tumors are included in the general group of "sarcoma," which we are no longer accustomed to consider malignant, and some of them are not even potentially malignant. Thus in the series of Wintz, as we shall see later, 42 cases (that is, 12 per cent of the total) are uterine sarcomas, an exceedingly rare condition, with a final cure of 57 per cent. In the series of Hintze are included epulis, this raising the percentage of cures of sarcoma of the jaw to 50; mixed parotid tumors, with cures of 58.6 per cent; degenerated moles, raising the percentage of cures in melanosarcoma to 47.6, etc. By drawing a sharper borderline between the true sarcoma and its affiliated lesions, the percentage of cures would dwindle down appreciably. Such a procedure would have the additional advantage of leading to a better harmonization of the statistics from the various sources.

A review of the cases treated at Harper Hospital shows that during the period of 1922 to 1929, inclusive, some 3,000 cases of malignancies were dealt with and that, of these, 222 cases were classified as being sarcoma. Conditions now considered as essentially benign, such as benign giant-cell tumor (giant-cell sarcoma) of bone, epulis (giant-cell sarcoma) of jaw, mixed tumors (myxochondro-endothelioma) of parotid, etc., were eliminated from the general statistics of the sarcoma group. In the completion of the final results, all patients who reported to the department, whether or not they received complete treatment, were included, and all those who could not be traced (2.5 per cent) were considered as dead from sarcoma. Likewise, patients who are known to have succumbed to other causes than sarcoma were considered as having died from sarcoma. In this manner, the percentage of from

TABLE I.—TOTAL CASES SARCOMA
(Harper Hospital, 1922–1929, inclusive, 5- to 12-year survival.)

I.	Bone sacroma	39	12.5%
II.	Lymphosarcoma	31	30.0%
III.	Malignant melanoma*	21	85.0%
IV.	Melanosarcoma	30	10.0%
V.	Sarcoma of soft parts	101	34.0%
	Total	222	30.0%
	(By discounting malignant melanoma)	201	25.5%

* The group of malignant melanomas includes degenerated moles clinically showing signs of active malignancy but in which no biopsy was made to confirm the diagnosis, it being our experience that biopsy may be harmful (7).

5- to 12-year survivals for the total group of 222 cases was 30 per cent, and if the cases of malignant melanomas (degenerated mole) are deducted, 25.5 per cent. The results for the individual groups of bone sarcoma, lymphosarcoma, malignant melanoma, melanosarcoma, and sarcoma of the soft parts are shown in Table I. In the group of sarcoma of the soft parts, there were 101 cases with a survival of 34 per cent. This group forms the basis of the present study, and the principles of radiotherapy expounded further below are largely the result of experience gained in connection with its clinical observation and treatment.

It may be mentioned here, in a general way, that irradiation in the cases at Harper Hospital was carried out with the so-called deep x-ray therapy. The quality of the rays used was 0.13–0.14 Å. (200 kv., 1–1.5 mm. Cu and 1 mm. Al as filters), and the quantity varied from 30 to 100 per cent S.U.D. per focus, according to the type of lesion and method of treatment. This latter will be dealt with more *in extenso* when discussing the individual groups of sarcomas.

FIBROBLASTIC SARCOMA

"Fibroblastic sarcoma" is more or less a collective pathologic term, which for a while included nearly all of the sarcomas of the soft parts of indisputable connective tissue origin. In this manner it extended its scope over a wide domain of tumors of rather complex histogenesis. With acquired clinical knowledge, however, this scope gradually narrowed down and groups became detached, as, for example, melanosarcoma, lymphosarcoma, etc., which took up the place of distinct entities. For the past decade, criteria of radiosensitivity began to burrow themselves rather deeply in the field of classification and now we see again there arise new groups, such as myxosarcoma, etc., which possess sufficient characteristic features as to permit their separation from the main group. This process of separation will continue until eventually specific entities will replace the entire group. Histogenetic considerations undoubtedly will play here the greatest rôle.

As it stands at the present time, we include under the heading of fibroblastic sarcoma all those sarcomatous tumors of the soft parts which cannot be placed in any of the well-characterized subgroups. They may arise from almost any location where connective tissue is found—subcutaneous and submucous layers, intermuscular fasciæ, peri- and endomysium of muscles, tendon sheaths, supporting connective tissue of all viscera, etc. Structurally it is customary to divide them into spindle-cell, polymorphous cell, round-cell, alveolar cell sarcoma, etc. Some of them are then further subdivided into large cell and small cell variety, this subdivision permitting certain deductions as to the degree of malignancy and especially of radiosensitivity. In the spindle-cell sarcoma group, which no doubt represents the bulk of the fibroblastic sarcomas, we find, for example, that the large cell variety represents the greatest potentiality of clinical malignancy, with rapid growth, wide local infiltration, and extensive metastases to lungs, lymph nodes, liver, bones, and other organs, whereas the small cell variety shows a somewhat more benign course. Of the latter, a subgroup has been detached under the name of fibrosarcoma, which, except for a marked

tendency to local recurrence, is considerably more benign, metastases occurring only rarely in the late stages and in those cases which went through a great number of recurrences. As we shall see later, this type of sarcoma is included by some investigators with certain other similar tumors to form the subgroup of neurogenic sarcoma. Concerning the more rounded cellular elements, the opinion is not infrequently expressed that they represent forms of spindle-cell sarcoma under peculiar situations or that they belong to entirely different groups. If, for instance, a large spindle-cell sarcoma is very vascular and its cells possess very little capacity of differentiation, the structure may develop into that of a polymorphous cell, or even large round-cell sarcoma. On the other hand, the alveolar cells, which occur with great regularity in melanosarcoma, are often regarded as being of epithelial origin.

It is not at all surprising from the point of view of radiosensitivity that this ill-defined fibroblastic sarcoma group should represent the greatest variation. In a general way, the rules of radiosensitivity accord with the morphologic structure: the greater the undifferentiation of the cells and the vascularity of the tumor and the less the amount of paraplastic structures, the more responsive to irradiation the sarcoma, and *vice versa*. In this respect the above morphologic classification seems to be of decided advantage. However, there are occasionally encountered tumors which, although possessing from the histological standpoint all the criteria of highest radiosensitivity, prove absolutely refractory to the largest doses of roentgen rays that can be tolerated. The only explanation for such behavior is to be sought in the fact that histogenetically such tumors may belong to an entirely different group, such as certain obscure alveolar cell sarcomas to the melanosarcoma group, etc. The exceedingly high radiosensitivity of some of the round-cell sarcomas, on the other hand, suggests a close relationship, if not identity, with lymphosarcoma. By disregarding these peculiarities, we may say that, in practice, most sarcomas belonging to the fibroblastic group are more or less radiosensitive. As to degree, the large cell varieties because of the greater pathological potentialities of malignancy, respond somewhat more readily than the small cell varieties. A complete disappearance of even large tumor masses is brought about not infrequently and the failure of a permanent cure must be attributed to the uncontrollable systemic extension of the disease rather than to the lack of radiation response. Because of the bulkiness of most of these tumors, irradiation must be carried out with rather large massive doses (90–100 per cent S.U.D.) by using penetrating rays (200 kv. or more and heavy filters). The so-called "sarcoma dose" which is supposed to represent about 60 to 70 per cent of an erythema dose, and which was ushered in at the beginning of deep roentgen therapy with such great promise, must now be completely abandoned and radiation pushed to the maximum tolerance limit. In all instances in which surgical intervention may be used to advantage (wide excision, amputation, etc.), such a

TABLE II.—SARCOMA OF SOFT PARTS
(Harper Hospital, 1922–1929, inclusive)

	(1) Number of cases									(2) 5- to 12-year survival									
Year	22	23	24	25	26	27	28	29	Total	22	23	24	25	26	27	28	29	Total	%
Fibroblastic	6	11	9	8	7	10	2	9	62	1	2	2	2	2	1	1	2	13	21.0
Fibrosarcoma	2	2	5			1	2	5	17	2	1	4			1	2	4	14	82.4
Neurosarcoma	1					1	1		3						1	1		2	66.6
Myxosarcoma		1	2		2		2	1	8			2				1	1	4	50.0
Leiomyosarcoma	1	1	1	2		1	1	1	8								1	1	12.5
Rhabdomyosarcoma		1	2						3										0
Total cases									101									34	34.0

procedure is associated with roentgen therapy. If an apparent eradication of the sarcoma has been brought about by the operative method, irradiation is supplemented in a prophylactic manner for the treatment of such regions as are known to form the seat of predilection of eventual metastases, such as the lungs, regional lymph nodes, liver, etc.

In our series (Table II), 61 cases of various types of fibroblastic sarcoma were treated, mostly by a combination of surgery and irradiation, an apparent cure having been obtained in 21 per cent. In some of the cases the disease was quite disseminated at the time of treatment; in others the surgical procedures, consisting chiefly in local excisions, were carried out with great conservatism, so that the favorable results in the group must be ascribed mainly to the radiation therapy.

FIBROSARCOMA; NEUROSARCOMA

The condition that histologically is classified as fibrosarcoma also clinically presents characteristics which make its separation from the ordinary spindle-cell sarcoma group of decided advantage. On the other hand, certain common features were noted with the neurosarcoma, especially as it concerns the histogenesis and radiosensitivity. This induced Ewing, on the assumption that all these lesions are of a neurogenic origin, to create a distinct group, the so-called "neurogenic sarcoma group." Quick and Cutler (16), Stewart and Copeland (24), and more recently Adair (1), by reviewing the material at Memorial Hospital, were able to still further enlarge the scope of the group, so that, according to the last publication (1) in 1932, there were admitted to Memorial Hospital during the period from 1916 to 1932 a total of not less than 317 patients afflicted with neurogenic sarcoma. On the basis of a review of this material, the present definition of neurogenic sarcoma is that it represents a later, malignant development of neuroma, neurofibroma, fibroma molluscum, and plexiform or cirsoid neuroma. As such, according to Stewart and Copeland (24), it is but one link, the final link, of a chain leading through varied clinical pathologic entities up to fully developed von Recklinghausen's neurofibromatosis with all its diverse related manifestations. This, then, also indicates that most neurogenic sarcomas are not malignant from the beginning. Just where the borderline lies is exceedingly difficult to estimate, but it may serve to explain to some extent the apparent discrepancies in the statistics dealing with the end-results of the fibroblastic (spindle-cell) sarcoma group as a whole. If doubtful links in the chain are declared malignant, this may increase the percentage of favorable results, whereas if only the undoubtedly sarcomatous forms are included, the final cures may appear less numerous. The clinical picture is characterized by the fact that a small tumor, which not infrequently has been present for a number of years, starts to enlarge very slowly. The patient reports to his physician, who removes the lesion, usually declared as benign, only to find that within a short time there is a recurrence. A second or even third excision is made before the malignant nature is realized and the criteria of sarcoma are recognized histologically. By this time the disease has acquired a great tendency to extend into the surrounding structures, to the regional lymph nodes, or to the lungs. When such a situation has arisen, a differentiation from the true spindle-cell sarcoma may appear exceedingly difficult if not impossible, on the basis of the morphology of the tumor tissue alone. In certain instances, the prompt response to irradiation may be construed as a criterion in favor of true spindle-cell sarcoma.

The degree of radiosensitivity of the fibrosarcoma due to the more adult nature of the tissues of which it is composed, is considerably lower than that of the fibroblastic spindle-cell sarcoma, but somewhat higher than that of the neurosarcoma. Because of this, and since radical excision can be accomplished with ease in the

TABLE III.—TABULAR ARRANGEMENT OF CASES OF SARCOMA OF SOFT PARTS

(Harper Hospital, 1922–1929, inclusive)

No.	Case	Sex	Age	Histologic Diagnosis	Origin	Stage	Type of Treatment	Dose	Series	Extent of Treatment	Extent of Metastases	Result	Duration Since Onset (Yrs.)	Duration Since Treatment		Remarks
														Dead (Yrs.)	Well (Yrs.)	
							1922									
1	A.S.	M	9	Angio-	Back	Loc.	Bio., DX	Ma	3	Lesion; skull	Later: brain, lungs, pleura	+	0.1	1.3		
2	M.S.	F	55	Round-cell	Neck	d.m.	Bio., DX	Ma	2	Neck	Glands, abd., gast. hemorr.	+	0.3	0.5		
3	A.C.	F	31	Fibro-	Hand	Loc.	4 Exc., DX	Ma	2	Hand		W	2.5		12.6	
4	C.F.	F	52	Mixed cell	Stern. reg.	Loc.	Bio., DX	Ma	2	Chest	Later: lungs, mediast.	+	1.0	0.5		
5	F.H.	M	18	Sm. spindle-cell	L. thigh	r.m.	Bio., DX	Ma	1	Lesion; inguinal glds.	Inguinal gl.; later: lungs	+	2.0	0.6		
6	A.B.	F	30	Fibro-	Hip	Loc.	2 Exc., DX	Ma	1	Hip		W	7.0		12.0	
7	S.B.	F	48	Polymorph. cell	Breast	Loc.	Loc. Exc., DX	Ma	1	Breast; reg. glands		W	0.3		12.0	
8	E.C.	F	59	Leiofibro-	Aortic wall	r.m.	2 Lapar., DX	Ma	1	Abdomen	Abdominal glands	+	1.0	1.7		
9	R.G.	M	52	Round-cell	Thymus	r.m.	Bio. glands, DX	Ma	1	Chest, neck	Cervical glands	+	0.5	0.3		
10	A.W.	M	33	Neurofibro-	Neurogenic		Bio., DX	Ma	1	Tumor of chest only	von Recklinghausen's dis. gener.	+	25.0	1.0		
							1923									
11	J.G.	F	11	Vasc. rd.-cell	Broad lig.	d.m.	Lap., Bio., DX	Ma	4	Abdomen, skull	Lumbar spine, skull	+	0.3	1.6		
12	P.F.	F	33	Leiomyo-	Deg. ut. fib.	d.m.	Hyster., Rec., DX	Ma	3	Abdomen, all lym. glds.	Rec. abd., all lymph glds.	+	1.0	0.7		
13	B.J.	M	62	Sm. round-cell	Sclera	loc.	Enucleation, DX	Ma	1	Orbit, reg. glands		W	0.3		11.9	
14	E.R.	F	36	Spindle-cell	Breast	d.m.	Rad. amp., DX	Ma	1	Lymph glds., abd.	All lymph glands, abdomen	+	2.0	0.1		
15	T.W.	F		Fibro-	Back of neck	loc.	2 Excisions, DX	Ma	1	Neck	?	+	5.0	4.0		
16	N.S.	F	45	Spindle-cell	Maxilla	r.m.	Bio., DX	Ma	1	Face, neck	Entire face, glds., neck		0.3			(?+)
17	H.S.	M	40	Spindle-cell	Maxilla	d.m.	2 Excisions, DX	Ma	2	Face, all lymph glds.	Face, all lymph glands	+	3.0	0.2		
18	A.W.	M	62	Spindle-cell	Thigh	d.m.	Bio., DX	Ma	2	Thigh, lungs	Lungs	+	1.6	0.2		
19	W.D.	M	34	Spindle-cell	Pelvis	d.m.	Lapar. Bio., DX	Ma	6	Generalized	Lymph glds., lungs, skin	+	2.0	2.2		
20	J.K.	M	51	Myxo-	Bladder	loc.	Suprapub. Cystot., DX	Ma	4	Pelvis, abdo.	Later: lungs	+	1.0	3.5		
21	E.W.	M	47	Spindle-cell	Abd. wall	loc.	Incomp. remov., DX	Ma	1	Abdomen			0.8			Untr.
22	H.H.	M	36	Fibro-	Abd. wall	loc.	Ra. Excision, DX	Ma	1	Abdomen		W	5.0		11.0	
23	A.T.	F	12	Large rd.-cell	Lumb. reg.	loc.	Bio., DX	Ma	3	Lumbar area	Trans. myelitis (?)	+	0.5	0.7		
24	T.R.	F	35	Embryonal cell	Retroperiton.	loc.	Removal, DX	Ma	1	Abdomen, pelvis		W	2.0		11.0	
25	H.B.	F	72	Spindle-cell	Breast	loc.	Loc. excision, DX	Ma	1	Breast, reg. glds., abd.	?	+	1.5	1.6		
26	C.D.	F	38	Rhabdomyo-	Kidney	d.m.	Incompl. remov., DX	Ma	1	Abdomen, chest	Abdomen, mediast. glds.	+	2.0	0.4		

							1924									
27	P.O.	M	50	Embryonal cell	Retroperit.	r.m.	Laparotomy, DX	Ma	1	Abdomen	Abdominal, ascites	+	0.5	0.5		
28	G.J.	M	44	Myxo-	Forearm	loc.	Excisions, 2, DX	Ma	1	Forearm, reg. glds.		W	1.0		10.6	
29	T.D.	F	29	Fibro-	Sole	loc.	Excision, DX	Ma	1	Sole	(?)	+	0.5	5.1		
30	J.F.	F	53	Polymorphous c.	Shoulder	loc.	Excision, DX	Ma	1	Shoulder, reg. glds.	(?)	+	2.6	4.0		
31	W.F.	F	70	Polymorphous c.	Axilla	loc.	Excision, DX	Ma	1	Axilla, neck, chest		+	1.0	2.0		+ Acute append.
32	M.C.	F	48	Spindle-cell	Breast	d.m.	DX	Ma	3	Breast, reg. glds., mediastinum	Regional glds., mediast.	+	1.0	0.8		
33	J.U.	F	42	Fibro-	Scapular reg.	loc.	Excis., rec., DX	Ma	2	Scap. reg. ax. glds.		W	7.0		10.6	Now pulm. T.B.
34	A.M.	F	41	Spindle-cell	Leg	loc.	Excision, DX	Ma	1	Leg, groin, abdomen			1.0		10.6	
35	C.S.	F	35	Spindle-cell	Neck	loc.	Excis., rec., DX	Ma	1	Neck, all lymph glds.		W	0.7		10.3	
36	S.L.	M	39	Fibro-	Post. thor. wall	loc.	6 Excisions, DX	Ma	1			W	8.0		10.2	
37	M.W.	F	67	Fibro-	Dorsum foot	loc.	DX, amputation	Ma	4			W	1.0		10.2	
38	G.G.	M	30	Spindle-cell	Thigh	d.m.	Excision, DX	Ma	1	Thigh, pelvis, chest	Lungs	+	1.0	0.3		
39	M.W.	F	5	Embryonal cell	Kidney	loc.	Nephrect., DX	Ma	3	Abdomen, chest	Later: lungs, liver	+	0.3	2.0		
40	F.D.	F	52	Rhabdomyo-	Thigh	d.m.	Bio., DX	Ma	1	Thigh incompl.	Liver	+	2.0	0.1		
41	F.M.	M	33	Fibro-	Finger	loc.	Excision, DX	Ma	1	Finger, reg. glands		W	0.6		10.0	
42	G.K.	F	38	Leiomyo-	Deg. ut. fibroid	loc.	Hysterect., DX	Ma	5	Pelvis, abdomen	Later: abd. rec., ascites	+	1.0	3.0		
43	M.W.	F	40	Angio-	Sclera	loc.	Excision, DX	Ma	3	Orbit, neck	Later: metas. lymph glds. chest	+	2.0	3.5		
44	R.A.	F	56	Rhabdomyo-	Kidney	loc.	DX, removal	Ma	1	Abdomen		+	2.0	0.1		Post-op. death
45	A.M.	M	35	Myxo-	Nose	loc.	Excis., DX, Ra.	Ma	3	Nose, neck		W	0.6		10.5	
							1925									
46	L.S.	F	24	Spindle-cell	Fascia lumb. muscles	loc.	Incompl., Ex., DX	Ma	2	Abdomen			0.5			(?+)
47	M.M.	F	33	Round-cell	Ovary	loc.	Removal, DX	Ma	1	Abdomen		W	0.5		9.5	
48	P.T.	M	30	Spindle-cell	Thigh	loc.	Bio., DX	Ma	3	Thigh	Later: lungs	+	0.3	1.0		
49	J.S.	M	55	Spindle-cell	Thigh	loc.	2 Exc., DX	Ma	3	Thigh, pelvis	Later: lungs	+	0.9	1.3		
50	M.M.	F	28	Leiomyo-	Deg. ut. fib.	d.m.	2 Oper., DX	Ma	2	Abdomen, chest	Lungs		2.0			(? +)
51	S.P.	F	23	Spindle-cell	Eye	loc.	2 Exc., DX	Ma	2	Orbit		W	2.0		9.0	
52	B.G.	M	1	Spindle-cell	Neck	loc.	Excis., DX	Ma	1	Neck	Later: gen. metas.	+	1.0	4.5		
53	L.O.	M	38	Angio-	Retroperit.	loc.	Removal, DX	Ma	2	Abdomen, pelvis	(?)	+	0.6	1.0		
54	N.G.	F	30	Leiomyo-	Deg. ut. fib.	d.m.	Hysterect., DX	Ma	1	Pelvis, chest	Lungs	+	3.0	0.3		
55	T.F.	M	56	Cylindrical cell	Parotid	loc.	Excision, DX	Ma	1	Parotid		+	4.0	9.0		+ Endocarditis

Abbreviations: DX = Deep x-ray therapy with 200 kv., 1–1.5 mm. Cu and 1 mm. Al; Ma = massive (dose) indicating 90–100 per cent S.U.D. in one sitting; Fr = fractionated (dose) indicating 30–60 per cent S.U.D. at shorter or longer intervals; loc. = localized; r.m. = regional metastasis; d.m. = distant metastasis; + = dead; W = well.

TABLE III (*continued*)

No.	Case	Sex	Age	Histologic Diagnosis	Origin	Stage	Type of Treatment	Dose	Series	Extent of Treatment	Extent of Metastases	Result	Durt'n Since Onset (Yrs.)	Duration Since Treatment		Remarks
														Dead (yrs.)	Well (yrs.)	
								1926								
56	J.R.	M	35	Spindle-cell	Sclera	loc.	Excision, DX	Ma	1	Orbit		+	4.0?	4.5		+ Meningitis
57	J.L.	M	41	Myxo-	Abd. wall	d.m.	2 Excisions, DX	Ma	2	Abdomen, pelvis	Abd., inguinal glds.	+	5.0	0.6		
58	M.T.	F	15	Polymorph. cell	Thigh	loc.	Excision, DX	Ma	2	Thigh			0.2			Untr.
59	A.B.	M	20	Angio-	Retroperit.	d.m.	Expl. lap., DX	Incomplete treatment			Lungs	+	0.6	0.1		
60	C.B.	M	76	Spindle-cell	Thigh	loc.	Bio., DX	Ma	1	Thigh		+	2.0	3.5		+ Uremia
61	M.P.	F	20	Adeno-	Breast	loc.	Rad. amp., DX	Ma	2	Breast, reg. glds.		W	2.0		8.5	
62	L.S.	F	14	Spindle-cell	Neck	d.m.	Bio., DX	Fr	2	Neck, chest	Lungs	+	0.5	0.3		
63	F.J.	F	3	Alveolar cell	Eye	loc.	Enucleation, DX	Fr	2	Orbit, chest, abd.		W	0.5		8.3	
64	S.M.	M	39	Myxo-	Leg	loc.	Removal, DX	Ma	1	Leg, pelvis		+	4.0	2.0		
								1927								
65	F.B.	M	8	Round-cell	Retroperit.	d.m.	Explor. lapar., DX	Ma	12	Abdomen, chest, skull	Later: lungs, brain	+	0.3	3.0		
66	J.T.	M	22	L. spindle-cell	Neck	d.m.	Bio., DX	Ma	1	All lymph glds., abd., chest	Lymph glands		1.0			Untr.
67	J.S.	M	39	Spindle-cell	Thigh	d.m.	Amputation, DX	Ma	1	Thigh, chest	Mediastinum	+	0.6	0.5		
68	R.D.	M	31	Spindle-cell	Glut. reg.	loc.	Excision, DX	Ma	1	Pelvis, chest		W	0.5		7.5	
69	J.J.	F	57	Leiomyo-	Uterus	loc.	Hysterect., DX	Ma	1	Pelvis			?			Untr.
70	S.W.	M	50	Round-cell	Tonsil	r.m.	Bio., DX, Ra.	Ma	1	Oral cav., neck	Cerv. lymph glands		1.0			Untr.
71	G.R.	F	35	Sarcoma	Tonsil	d.m.	DX	Ma	1	Neck, lungs	Lungs	+	1.3	2.3		
72	L.M.	M	26	Spindle-cell	Appendix	d.m.	Laparotomy	Incomplete treatment			Miliary, peritoneum		1.0			(?+)
73	C.T.	F	36	Fibro-	Face	loc.	Excision, DX	Ma	2	Face, neck		W	1.0		7.0	
74	J.J.	F	21	L. round-cell	Neck	d.m.	Bio., DX	Ma	5	All lymph glds., chest, abd.	All lymph glds., mediast.	+	0.5	1.5		
75	T.G.	M	45	L. round-cell	Retroperit.	d.m.	Explor. lapar., DX	Incomplete treatment			Lymph glds., liver	+	1.0	0.1		
76	J.P.	M	51	Alveolar cell	Neck	d.m.	Bio., DX	Ma	3	Neck	Sternum, mediastinum	+	0.4	0.5		
77	W.P.	M	38	Neurofibro-	Forehead	loc.	Bio., DX	Fr	30	Forehead		W	2.0		7.0	Some lesion present

								1928								
78	C.C.	M	40	Neurofibro-	Thigh	loc.	Excision, DX	Ma	3	Thigh		W	17.0		6.8	
79	J.R.	M	35	L. round-cell	Tonsil	loc.	Excision, DX	Ma	1	Lymph glds., chest		W	0.5		6.5	
80	G.C.	F	24	Myxo-	Abd. wall	loc.	Excision, DX	Ma	2	Pelvis, abd.		W	2.0		6.4	
81	J.P.	M	59	Myxo-	Thor. wall	d.m.	Bio., DX	Incomplete treatment			Lungs, skin, abd.	+	1.0	0.1		
82	J.S.	F	45	Round-cell	Arm	d.m.	Excision, DX	Ma	1	Generalized	Lungs, skin, spine, skull	+	1.5	0.3		
83	E.K.	M	30	Fibro-	Finger	r.m.	2 Excis., DX	Ma	2	Finger, reg. glds.	Axillary glds.	W	3.0		6.0	
84	E.S.	F	61	Leiomyo-	Deg. ut. fib.	loc.	DX	Ma	5	Abdomen	Lungs, abd. rec.	+	1.0	3.0		
85	E.S.	M	26	Fibro-	Tib. tendon sheath	loc.	Excision, DX	Ma	1	Ankle		W	0.5		6.4	
								1929								
86	J.D.	M	55	Spindle-cell	Fasc. biceps	loc.	Bio., DX	Ma	5	Arm, chest	Later: lungs	+	0.4	1.0		
87	C.D.	F	60	Round-cell	Neck	loc.	Bio., DX	Ma	1	All lymph glds., chest, abd.	(?)	+	0.3	1.1		+ Apopl.
88	J.S.	F	48	Spindle-cell	Thigh	d.m.	Bio., DX	Ma	7	Thigh, chest, lymph glds.	Dist. lymph glds.	W	1.0		5.9	
89	J.P.	F	40	Angio-	Cerv. ut.	loc.	Hysterect., DX	Ma	2	Pelvis	Pelv.	+	1.0	2.0		
90	F.C.	M	40	Fibro-	Back of neck	loc.	Excision, DX	Ma	2	Neck	v. Recklinghausen's stigma	W	0.5		5.4	
91	C.S.	F	72	Fibro-	Arm	loc.	Excision, DX	Ma	2	Arm		+	1.0	0.2		+ Apopl.
92	J.F.	M	43	Spindle-cell	Sole	d.m.	2 Excisions, DX	Ma	2	Sole, pelvis	Lymph glds., skin, lungs	+	0.8	0.4		
93	B.R.	F	29	Alveolar cell	Forearm	d.m.	Bio., DX	Ma	4	Forearm, reg. glds.	Lymph glds., skin, liver	+	1.5			(?+)
94	H.P.	F	33	Leiomyo-	Uterus	loc.	Hysterect., DX	Ma	3	Pelvis, abd.		W	0.8		5.4	
95	M.H.	F	47	Fibro-	Palm	loc.	Excision, DX	Ma	1	Palm, reg. glds.		W	2.0		5.4	
96	W.H.	M	48	Mixed cell	Soft palate	loc.	Bio., Ra, DX	Ma	2	Head, neck		W	1.0		5.4	
97	H.K.	M	65	Fibromyxo-	Thigh	loc.	2 Excisions, DX	Ma	4	Thigh, reg. glds.		W	0.6		5.3	
98	C.G.	M	39	Spindle-cell	Leg (fascia)	d.m.	4 Excisions, DX	Ma	1	Chest	Lungs	+	3.0	0.2		
99	J.T.	F	4	Round-cell	Retroperit.	loc.	Expl. lapar., DX	Ma	5	Abdomen, chest	Later: lungs	+	0.3	1.0		
100	A.C.	F	35	Fibro-	Ankle	loc.	2 Exc., DX, Ra, amp.	Ma	3	Ankle, chest		W	1.5		5.3	
101	J.K.	F	39	Fibro-	Index finger	loc.	2 Excisions DX	Ma	5	Finger		W	7.5		5.1	

Abbreviations: DX = Deep x-ray therapy with 200 kv., 1–1.5 mm. Cu and 1 mm. Al; Ma = massive (dose) indicating 90–100 per cent S.U.D. in one sitting; Fr = fractionated (dose) indicating 30–60 per cent S.U.D. at shorter or longer intervals; loc. = localized; r.m. = regional metastasis; d.m. = distant metastasis; + = dead; W = well.

great majority of instances, surgical intervention must form the method of choice in the fibrosarcoma, irradiation to be carried out post-operatively in a prophylactic manner. In the neurosarcoma, radiation therapy constitutes the predominating procedure. The first entails the administration of larger doses in more massive series, whereas in the latter radiation is divided into small fractions and extended over a long period. In some of our cases of fibrosarcoma, excision was repeated several times (occasionally as often as six times), and each time followed by irradiation with a dose of from 80 to 100 per cent S.U.D., until finally a permanent control of the lesion was brought about. If a fibrosarcoma is inoperable from the beginning, the radiation therapy is pursued with fractionated doses of from 50 to 60 per cent S.U.D. and at longer intervals, so as to allow a greater tolerance of the normal tissues. A similar technic is followed in neurosarcoma, except for the fact that the fractions of the dose are still smaller (only from 30 to 40 per cent S.U.D.), since roentgen therapy most often extends over several years. Neither in fibrosarcoma nor in neurosarcoma is there an attempt made to extend the irradiation beyond the site of the primary lesion unless definite metastasis has already taken place.

The number of fibrosarcomas treated in our series includes 17, of which 82.4 per cent were apparently cured. In all instances, a combination of surgery and irradiation was used. The surgical interventions in the main consisted of local excisions excepting one case in which amputation was performed. The radiation therapy was carried out with the technic described above. The exceedingly high percentage of cures in this group, as compared to statistics from some other sources, may, in our mind, be attributed to the fact that a very careful pathologic selection of the malignancy index was made, the more undifferentiated forms being included in the spindle-cell sarcoma group.

The series of neurosarcoma comprises only three patients, one of whom is dead, and the other two alive seven years after incipiency of the treatment. In one of these latter, in whom operative removal was impossible, irradiation was carried out regularly for a period of seven years (thirty series), the lesion being now considerably smaller than at the beginning, but still having failed to disappear entirely. It is interesting that in very rare instances malignant tumors of the nerve trunks may appear quite radiosensitive. Stewart (23), for example, reports a ganglionic neuroblastoma, probably arising in the cervical sympathetic ganglion, of a young boy, which proved as sensitive to irradiation as lymphosarcoma. Large pulmonary metastases produced by this tumor "regressed dramatically, recovered and regressed again, until the patient could tolerate no further treatment."

MYXOSARCOMA

The chief sign of malignancy of myxosarcoma lies in the local effect on the surrounding structures. Due to the rather slow rate of growth, this effect develops only in the advanced stages, so that many myxosarcomatous tumors reach comparatively large sizes before they become uncomfortable to their hosts. Metastases to the regional glands or lungs occur usually very late. From the point of view of radiosensitivity, these tumors form a favorable group. They respond well to large doses (from 90 to 100 per cent S.U.D.) of roentgen rays, the regression occurring at a somewhat slower rate than in most other radio-responsive sarcomas, but complete disappearance, following repetition of several series of roentgen therapy, being not infrequent. In our series there are eight cases of myxosarcoma of various origin, four of which (50 per cent) have apparently been cured. In the remaining, metastases developed to the lungs, in one case nearly four years after complete disappearance of the primary tumor.

LIPOSARCOMA; XANTHOSARCOMA

The opportunity has escaped us to treat one single case of liposarcoma, but,

according to Stewart (23), "these malignant tumors of fat tissue afford the radiologist a happy relief." They show from moderate to marked radiosensitivity and even when they are made up of adult appearing fat cells, they will respond relatively well to irradiation, yielding to "doses little more than sufficient to cause regression of the more resistant lymphosarcomas." Brunn (2) and Selman (22) likewise reported favorable results in individual cases.

One case of xanthosarcoma irradiated by us (in 1930) responded very promptly, a phenomenon which was noted also by Stewart (23) in his cases. The exceedingly high radiosensitivity observed in both these types of tumors is very difficult to explain except, perhaps, in the sense that morphologic criteria can be invoked in the least as the responsible factor.

LEIOMYOSARCOMA; RHABDOMYOSARCOMA

The pathologic criteria of leiomyosarcoma are ill-defined. This fact greatly reflects on the statistical studies reported, some investigators claiming that the condition occurs rather frequently and others considering it as a rarity. Unbehaun (25), for example, reports 6 per cent (and later 3.4 per cent) of leiomyosarcoma in 356 uterine fibroids. Likewise Wintz (26), as already mentioned, reports 12 per cent of leiomyosarcomas in a total of 367 sarcomas of all types, with a final cure of 57 per cent. Corscaden and Stout (4), on the other hand, on the basis of numerous statistics collected from the literature, arrive at the conclusion that the condition is very rare, occurring in from 0.39 to 0.5 per cent of all cases of uterine myoma. Krauskopf (11) very recently published an article stating that he was able to record only 31 case histories of undoubted leiomyosarcoma from the entire literature: three involved the bladder, some the gastro-intestinal tract, a very few other organs as kidney, prostate, etc., and the remainder the uterus. The chief difficulty in the histologic diagnosis of myoma and myosarcoma lies in the variation of opinion as to the exact proportion of the embryonal and adult elements necessary for the classification. Furthermore, as Ewing (8) states, benign myomas may vary in structure in different portions and probably at different periods, but these changes constitute only a local and temporary acceleration of growth, without evidence that they will be transformed into malignant sarcomatous degeneration. However, this may be, we note that the radiosensitivity is low in all cases of myomas which present or are suspicious of sarcomatous degeneration. This phenomenon is so well known to roentgenologists that a degeneration, malignant or otherwise, of a myoma is considered *à priori* as indicative of a surgical procedure, irradiation being reserved only as a post-operative method. Even so, the results are most disappointing. Except for a few authors, who, no doubt as a result of looser histologic classification, are able to claim better results (57 per cent cure in the case of Wintz (26), treated mostly by surgery and post-operative irradiation), the remainder (Schreiner (21), Regaud and Lacassagne (17), Sage and Miller (20), and others) are unanimous in considering leiomyosarcoma as one of the most unfavorable groups of all malignancies. Of eight cases of leiomyosarcoma, seven originating from the uterus and one from the aortic wall, treated in our series with large doses (from 90 to 100 per cent S.U.D.), only one has remained well for a period of five years. All cases were treated by a combination of surgery and radiation therapy. In a few, moderate palliation, with temporary restraint of the growth of the tumor, was obtained.

In rhabdomyosarcoma, the criteria of radiosensitivity are nearly identical with those of the leiomyosarcoma and consequently the radiation results are equally unsatisfactory. Of three cases of rhabdomyosarcoma (two of the kidney and one of the thigh) treated by us, none survived one year following irradiation.

IDIOPATHIC HEMORRHAGIC SARCOMA OF SKIN (KAPOSI)

As the last group is mentioned the multiple hemorrhagic sarcoma of Kaposi, al-

though this condition occurs quite rarely. The local lesions appear to be moderately radiosensitive, but dissemination cannot be forestalled unless, perhaps, in the very early stages. In one of the cases treated in 1930 by us, there was an apparently satisfactory response in the beginning, but later recurrences and dissemination to more distant regions occurred and the patient died within two years from the beginning of the treatment. In the literature favorable results are reported by Guarini (9) in 30 cases, by MacKee (14) in 7 cases, Rosh (18) in 2 cases, Collins (3) in 1 case, Craver (5) in 1 case, and by others, but most of these cases were observed for a period of less than five years. Kren (12), in a more recent publication, states that, whereas formerly the disease was considered hopeless, there are now cases on record living after thirty years or longer. He adds, however, that every case of Kaposi sarcoma eventually dies of the disease, the question being only whether the patient survives to this end.

CONCLUSIONS

In reviewing the statistical results in relation to the therapeutic method used in this very complex group of sarcoma of the soft parts, it becomes apparent that neither surgery nor radiation therapy has hard and fast rules. As concerns the former, though the general principle may be that every operable sarcoma should be removed at once, there are instances in which primary radiation therapy may appear of greater benefit. Especially is this true of some highly cellular sarcomas of the fibroblastic group, such as round-cell sarcoma of the tonsil or any other location, reticulum-cell sarcoma, large spindle-cell sarcoma, etc., of the myxo-, lipo-, and xanthosarcomas and of the Kaposi sarcoma of the skin. Moreover, when biopsy is taken in all these instances, it appears considerably safer to attempt to remove a metastatic node *in toto* rather than to try to cut into the tumor proper. As concerns radiation therapy, the degree of radiosensitivity forms the basis of procedure. Yet radiosensitivity in the clinical sense may mean "spectacular" regression in one case and slow progressive tumor shrinkage in another. The criteria dominating such response must be closely scrutinized and classified. It will be found that in the majority of cases they may be harmonized to greater advantage with surgical indications and that, therefore, an association of surgical and radiotherapeutic methods in the treatment of sarcoma of the soft parts must constitute an essential and most desirable requirement. In the same sense, statistics dealing with a combination of the two methods rather than their opposition will prove of the greater clinical value.

BIBLIOGRAPHY

(1) ADAIR, FRANK E.: Neurogenic Sarcoma and its Allied Lesions: A Clinical Study. Surg. Clin. No. Am., 1932, **12,** 357–372.

(2) BRUNN: Discussion of Schwarz, G. Zur Kenntnis der retroperitonealen Liposarkome und ihrer röntgenologischen Symptomatik. Wien. klin. Wchnschr., 1927, **40,** 694.

(3) COLLINS, JAMES N.: Idiopathic Hemorrhagic Sarcoma: Report of a Case Treated by Roentgen Radiation. Am. Jour. Roentgenol. and Rad. Ther., 1931, **26,** 260–263.

(4) CORSCADEN, J. A., and STOUT, A. P.: Sarcoma of Uterus. Am. Jour. Roentgenol. and Rad. Ther., 1929, **21,** 155–167.

(5) CRAVER, LLOYD F.: Extensive Sarcoma of Skin Treated by Unfiltered Roentgen Ray. Arch. Dermatol. and Syphilol., 1927, **16,** 35–43.

(6) DE WAARD, T.: Über Sarkome und die Rezultate der chirurgischen Behandlung. Nederl. tijdschr. v. geneesk., 1927, **71,** 822–834. (Abstr. in Zentralbl. d. Radiol., 1927, **3,** 401.)

(7) EVANS, WILLIAM A., and LEUCUTIA, T.: The Treatment of Melanotic Tumors of the Skin: Pigmented Moles and Malignant Melanosarcomas. Am. Jour. Roentgenol. and Rad. Ther., 1931, **26,** 236–259.

(8) EWING, JAMES: Neoplastic Diseases. W. B. Saunders Co., 1928.

(9) GUARINI, C.: La cura del sarcoma idiopatico del Kaposi, con la röntgen-terapia. Arch. di rad., 1926, **2,** 400–403.

(10) HINTZE, A.: Die Erfolge der operativen und der Bestrahlungsbehandlung beim Sarkom (Bericht über 1000 Fälle). Arch. klin. Chir., 1930, **162,** Kongr. Heft, 345–360 and 42, 43.

(11) KRAUSKOPF, HENRY: Leiomyosarcoma: Analysis of 31 Recorded Histories, with Report on an Unusual Case in the Urinary Bladder. Am. Jour. Surg., 1933, **22,** n. s., 192–198.

(12) KREN, OTTO: Sarcoma idiopathicum hemorrhagicum (Kaposi) *in* Handbuch der Haut- und Geschlechtskrankheiten. Hrsg. v. J. Jadassohn, Vol. 12, Part 3. Geschwülste der Haut. II. Julius Springer, 1933, **10,** 891–1004.

(13) LEUCUTIA, T.: Irradiation in Lymphosarcoma, Hodgkin's Disease, and Leukemia (Statistical Analysis). Am. Jour. Med. Sci., 1934, **188,** 612.

(14) MACKEE, GEORGE M.: X-rays and Radium in the Treatment of the Skin (2nd ed.). Lea & Febiger, Philadelphia, 1927, p. 707.

(15) MEVES, FRITZ: Der Erfolg der Sarkomtherapie

in der Kieler chirurgischen Klinik (1914–1928). Deutsche Ztschr. f. Chir., 1931, **231,** 691–713.

(16) QUICK, DOUGLAS, and CUTLER, MAX: Neurogenic Sarcoma: A Clinical and Pathological Study. Ann. Surg., 1927, **86,** 810–829.

(17) REGAUD, C., and LACASSAGNE, A.: Quelques cas des sarcomes de l'utérus traités par les méthodes radiothérapiques. Arch. de l'Inst. de Rad., Paris, 1932, **2,** 409–420; also Strahlentherapie, 1930, **37,** 275–292.

(18) ROSH, RIEVA: Radiation Therapy for the Treatment of Kaposi's Disease. Radiol. Rev., 1929, **51,** 423–424.

(19) ROSTOCK: Ergebnisse der Röntgenbestrahlung bei Sarkomen. Klin. Wchnschr., 1927, **6,** 1730–1731; also Münch. med. Wchnschr., 1927, **74,** 1733; also Bruns' Beitr. z. klin. Chir., 1927, **141,** 81–101; also Fortschr. d. Therapie, 1928, **4,** 241–244.

(20) SAGE, EARL C., and MILLER A. J.: Leiomyosarcoma of the Uterus: Report of Case, with a Brief Review of the Literature. Am. Jour. Obst. and Gynec., 1928, **16,** 828–839.

(21) SCHREINER, BERNARD F.: A Clinical Study of Eight Cases of Myoma Malignum. Surg., Gynec. and Obst., 1929, **48,** 730–732.

(22) SELMAN, W. A.: Report of Case of Lipomyxosarcoma. Internat. Clinics, 1931, **1,** 106–140.

(23) STEWART, FRED W.: Radiosensitivity of Tumors. Arch. Surg., 1933, **27,** 979–1064.

(24) STEWART, FRED W., and COPELAND, MURRAY M.: Neurogenic Sarcoma. Am. Jour. Cancer, 1931, **15,** 1235–1320.

(25) UNBEHAUN, GERD.: Über die Häufigkeit des Sarcoma uteri. Klin. Wchnschr., 1932, **2,** 1152–1154.

(26) WINTZ, HERMANN: Ergebnisse der Röntgenbehandlung des Uterus Sarkoms. Riv. di rad. e fisica med., 1931, **5,** Fortschr. Busi Pte., 523–534. (Zentralb. f. d. ges. Rad., 1933, **14,** 538–539.)

(27) WOLLNER, W.: Ergebnissleiner 10 jährigen Sarkombehandlung. Bruns' Beitr. z. klin. Chir., 1926, **138,** 39–57. (Abstr. in Zentralbl. f. Radiol., 1926–1927, **2,** 519, 520.)

THE ROENTGEN TREATMENT OF CERTAIN TYPES OF ARTHRITIS[1]

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OSLER has remarked that, when a score of remedies are used for one disease, it is probable that none of them has much value. To add still another weapon, or rather to remind you of the availability of still another weapon, for the treatment of arthritis would, therefore, seem to be superfluous; however, the simplicity of application of this weapon, its effectiveness in acute cases of a specific type, and its freedom from objectionable sequelæ make its further utilization worth while.

The first report of the use of roentgen therapy in the treatment of arthritis was that of Sokoloff (1), who, in 1897, used it for the relief of pain in articular rheumatism. Stenbeck (2), in 1898, reported the results of treatment of 52 cases; 40 per cent of these cases showed "considerable improvement" and another 40 per cent "at least subjective improvement." About thirty further papers appeared on the subject up to 1930, since which time numerous articles have been published. Its first mention in the American literature was in Williams' classic book, published in 1901 (3).

Since there are many different types of arthritis, it is important that we be clear in describing the types amenable to treatment; a fairly simple classification is that of Allison and Ghormley (4):

(*A*) Etiology known
1 Traumatic
2 Infectious (pyogenic, tuberculous, gonorrheal, etc.)
3 Neuro-arthropathic (tabetic, syringomyelic, leprous)
4 Metabolic (gouty)
5 Constitutional (hemophiliac) and anaphylactic

(*B*) Etiology unknown
1 Degenerative (hypertrophic)
2 Proliferative (atrophic)
3 Rheumatic fever

Of these, the only types we will discuss are the infectious and the degenerative. These have been subdivided, for the purpose of analyzing results, into (1) acute infectious (gonorrheal) and (2) acute infectious (unclassified); chronic infectious; chronic degenerative.

RATIONALE OF ROENTGEN THERAPY

The reason for the beneficial effects of x-ray in cases of arthritis is not known. However, the beneficial effect of small doses of x-rays on acute inflammatory and acute painful lesions of a superficial type has been amply demonstrated and is now generally appreciated. X-rays cause destruction of lymphocytes and other radiosensitive cells, thereby liberating proteins which are set free in the tissues; these appear to stimulate localization of the inflammatory process and absorption of the regional exudate. Natural tendency to repair is speeded and hyperemia subsides. Either as a result of the decrease in swelling or from some cause we do not understand, there is also an analgesic effect. Since x-rays were observed to have this beneficial effect on superficial lesions, it was natural to expect similar results from the treatment of deep-seated and intra-articular inflammatory processes, and such were actually observed. This established their use in acute infectious arthritis and especially in acute gonorrheal arthritis.

The reason for the beneficial effects of x-rays on the chronic degenerative type of arthritis is harder to explain. It is reasonable to suppose that when inflammatory peri-articular exudate complicates these chronic cases, its tendency to absorb should be hastened by radiation;

[1] Read before the Radiology Section of the California Medical Association, at the sixty-fourth annual session, Yosemite National Park, May 13–16, 1935.

similarly, the analgesic effect of x-rays should make the patient feel better, at least temporarily. It is certain, however, that atrophy of the cartilage, persistence of marginal osteophytes, and sclerosis of juxta-articular bone will not be influenced in the least by moderate doses of x-rays.

TECHNIC

While the superficial location of some of the lesions (such as in the wrist joint) did not necessitate it, all cases were treated under uniform conditions in the deep therapy department. The aim of treatment was to deliver a small dose of x-rays, approximately 10 per cent of a full dose, to the affected joint or joints, twice a week, for two or three weeks. The dosage in roentgens, measured in air, without back-scatter, was usually 80 r to each field. A few of the cases received double this dose at each sitting (experimentally), and six cases were treated only over some of the involved articulations, the other joints being used as controls. The results of increasing the dosage were, as one might expect, disappointing. The results in the control cases were very instructive and are separately described below.

The actual technical factors employed were as follows: 200 kv.p., 30 ma., filter 0.5 mm. Cu plus 1.0 mm. Al, lambda effective 0.16 Å., distance and field variable according to the depth and the size of the affected joint. For example, a wrist would receive a beam of 10 cm. diameter at 50 cm. T.S.D., while a hip would receive a beam of 25 cm. diameter at 70 cm. T.S.D. Most joints were treated through ventral and dorsal fields, some through mesial and lateral ones. Except in the case of the wrist, hand, and foot, most joints received two fields on each treatment day. In the seven spine cases treated (patients with chronic hypertrophic arthritis), large dorsal fields only were treated, the field being usually 20 by 35 cm., rectangular.

Some of the acute cases were so exquisitely tender that they could not be lifted from the guerney to the treatment bed; these were treated on the guerney, without attempting to project the beam in a true ventral or lateral direction on the first treatment day. Almost all of the acute cases had such rapid and, indeed, almost theatrical relief of pain, that they could be centered correctly on subsequent days.

TYPES OF CASE TREATED

Since the response of arthritis to the more simple and time-honored remedies varies somewhat with the economic status of the patient, his ability to secure adequate rest, a proper diet, and so forth, we will report in this paper only a group of patients from one general economic level, all 49 cases having been patients in the City and County Hospital in San Francisco.

Most of the cases of acute gonorrheal arthritis on the Stanford and a few on the University of California Urological Service at the San Francisco Hospital, during a period of approximately 18 months, were treated (30 cases). Nine cases of acute infectious, non-gonorrheal arthritis of various types from different services in the hospital were treated. Three cases of chronic infectious, and seven of chronic degenerative arthritis were also treated. Some of the acute infectious, unclassified, cases were thought at first to be gonorrheal, but their subsequent course, absence of positive smear findings, and so forth, caused their reclassification later.

All of the cases classified as gonorrheal had definite clinical findings of that disease, and almost all had positive smears while in the hospital. None of the non-gonorrheal types were due to specifically identified organisms, such as tubercle bacilli, pneumococci, or so forth. However, the diagnoses were made only after careful examination, and had been made clinically by independent physicians.

RESULTS IN CASES OF GONORRHEAL ARTHRITIS

Thirty cases, with a total involvement of 80 joints, were treated. The ages of the patients varied from 20 to 60. The joints involved included all those of the extremi-

ties and, occasionally, articulations such as those of the spine, jaw, sternum, and clavicle. Thirteen cases were so markedly improved as to warrant the word "cured," 15 cases were much improved, and two cases showed no improvement. Of the 80 joints treated, 75 (93.7 per cent) were improved, and five (7.3 per cent) were unimproved. The 75 joints improved may be divided into 30 "cured" and 45 improved. In five cases of multiple joint involvement, one joint was left untreated as a control. In all five cases, the patient continued to complain of pain, and swelling persisted in the untreated joint, while the other (treated) joint or joints cleared up. Three of the cases received later roentgen treatment to the "control" joint, with subsequent complete improvement. One case was treated subsequently but did not improve at all (although the two other joints in this patient had previously responded with perfect results); one case was not treated, and slowly improved spontaneously.

The average number of treatments in the "cured" group was 5.3, in the "improved" group 5.8, and in the unimproved group 4.5. The actual number of treatments to individual joints varied from one to ten, the majority receiving five or six treatments. Some case reports from the series will serve as illustrations.

Case 6. A. D., male, 27 years of age, S.F.H., No. 135,455, was admitted on Nov. 30, 1933. His left knee and both ankles had been stiff, swollen, and painful for three weeks. His temperature was 102° F. He had contracted gonorrhea two years before, which had never completely cleared up: smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, he was treated by bed rest and given two injections of neoarsphenamine. His joints did not improve, and two weeks after entry roentgen therapy was commenced, all three joints receiving 80 r to each of two fields, biweekly for four doses. Swelling was almost completely gone eight days after commencing therapy and the patient was able to walk without pain. Two days later he was discharged as cured. One year later he returned to the hospital on account of a urethral stricture; his joints had remained well.

Case 9. R. G., male, 33 years of age, S.F.H., No. 131,390, was admitted on Sept. 17, 1933. Both knees had been swollen and painful for one week. His temperature was 99.5° F. He had contracted gonorrhea thirteen years previ-

TABLE I.—SUMMARY OF RESULTS, ACCORDING TO NUMBER OF CASES TREATED

Type of Arthritis	No. of Cases	Cases Free from Symptoms	Cases Improved	Cases Unimproved
Acute Gonorrheal	30	13	15	2
Acute Infectious	9	4	2	3
Chronic Infectious	3	2	..	1
Chronic Hypertrophic	7	1	4	2
Total	49	20 or 40%	21 or 43%	8 or 17%
Total Percentage Improved 83%				

TABLE II.—SUMMARY OF RESULTS, ACCORDING TO NUMBER OF JOINTS TREATED[2]

Type of Arthritis	No. of Joints[2]	Joints Free from Symptoms	Joints Improved	Joints Unimproved
Acute Gonorrheal	80	30	45	5
Acute Infectious	13	6	2	5
Chronic Infectious	10	3	6	1
Total	103	39 or 38%	53 or 51%	11 or 10%
Total Percentage of Joints Improved 89%				

[2] Involvement of a wrist or ankle, with or without some joints of the adjoining hand or foot, was counted as only one joint.

ously, and had had five recurrences. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, he was treated by bed rest. Seven days after admission, roentgen therapy was begun, 80 r to each of two fields, over each knee, biweekly for four doses. One week after commencing therapy, marked improvement was noted and two weeks later the patient was discharged, completely relieved.

Case 14. C. K., male, 32 years of age, S.F.H., No. 121,311, was admitted on Dec. 7, 1932. His right knee had been swollen and acutely painful for one week; his right shoulder had been swollen and painful for four weeks. His temperature was 100.5° F. Eleven years previously he had contracted gonorrhea, which had never completely cleared up. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, the patient was treated by bed rest and roentgen therapy, receiving 96 r to one field over each joint, biweekly for four doses. The temperature had dropped to normal two days after commencing treatment, and four days later the knee showed much improvement. One week later the patient was discharged, the following note being entered in his chart by the attending ward physician: "The only treatment given to this patient's affected joints was x-ray with bed rest. The improvement was remarkable. The patient has been ambulatory for two days and feels fine. He is no longer a hospital case and is being discharged to the clinic for further urethral medication." (Note: Three weeks after dismissal this patient developed acute gonorrheal arthritis of both ankles. He was given similar roentgen treatment to these joints, but without being hospitalized. Complete relief of symptoms and signs followed.)

Case 16. E. K., male, 29 years of age, S.F.H., No. 124,092, was admitted on Dec. 25, 1932. His left wrist, right elbow, and right shoulder had been acutely painful and stiff for three days; his wrist and elbow were very red and hot. His temperature was 99° F. He had contracted gonorrhea one year ago, with recurrence five months ago. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, the patient was treated by bed rest and roentgen therapy, the latter commencing four days after admission (by which time the patient's temperature had risen to 103° F). The wrist and shoulder were treated but the elbow was left untreated, as a control, by inserting a lead slide above the copper filter when this joint was under the tube. Four days after commencing therapy this note was entered in the chart by the ward physician: "This patient was given x-ray to the left wrist and right shoulder, but the right elbow was left for a control. Believe it or not, the two treated joints have improved both clinically and symptomatically, but the right elbow is getting progressively worse." Two weeks later the wrist and shoulder were apparently cured. However, owing to the severe pain in the left elbow, roentgen therapy had been commenced over that joint four days after the above-mentioned chart-entry. For some unknown reason, the elbow improved only slightly. The temperature had dropped to normal ten days after commencing therapy. The shoulder and wrist received a total of four treatments, 88 r biweekly; the elbow received seven treatments, at a similar rate. After a rest of one month, four more treatments were given to the elbow. But fibrous ankylosis supervened and the patient's elbow had to be given physiotherapeutic and orthopedic care. The wrist and shoulder remained perfectly well.

Some of the cases of acute gonorrheal arthritis had received foreign protein therapy of various kinds before commencing their roentgen therapy, but without benefit. None received pyrotherapy. Only one of the cases is known to have progressed to fibrous ankylosis following failure of therapy (the "control" elbow in Case 16, above mentioned). Two other cases are listed as unimproved; one of these had partial destruction of the joint surfaces before roentgen therapy was started, and the other patient received only two treat-

TABLE III—CASES OF ARTHRITIS TREATED BY X-RAYS

I. Gonorrheal

No.	Sex Age	Diagnosis	No. of Joints Involved	Dosage r in Air	No. of Treatments	Result	Remarks
1	M 22	Gc. arth., acute, severe, left wrist, three weeks	1	88 r biweekly	8	Symptom-free	.....
2	M 57	Gc. arth., acute, elbows and wrists, four weeks	4	80 r biweekly	7	Improved	Left wrist symptom-free
3	M 44	Gc. arth., severe, both knees, eight weeks	2	88 r biweekly	7	Unimproved	Rt. knee had bony erosive changes
4	M 46	Gc. arth., multiple joint involvement, esp. severe in ankles, left knee, and right shoulder	4	100 r biweekly	6	Marked improvement	Left knee used as control and finally treated on account of severe pain
5	M 24	Gc. arth., subacute, feet, ankles, and knees	6	80 r biweekly	7	Improved	.....
6	M 27	Gc., arth., ankles and left knee, acute, severe	3	80 r biweekly	4	Marked improvement	Well one year later
7	M 31	Gc. arth., left shoulder, acute	1	80 r biweekly	2	Improved	Treatment discontinued by patient
8	M 36	Gc. arth., right knee and toe, acute	2	80 r	1	Improved	.....
9	M 33	Gc. arth., both knees, acute	2	80 r biweekly	4	Symptom-free	.....
10	M 36	Gc. arth., left ankle and knee	2	80 r biweekly	4	Improved	.....
11	M 38	Gc. arth., both knees and ankles, acute	4	80 r biweekly	6	Marked improvement	Developed arth. left hip; treated and cured
12	M 26	Gc. arth., left knee and both ankles	3	100 r biweekly	2	Marked improvement	Five months later acute exacerbation treated with relief
13	M 37	Gc. arth., left knee, acute	1	80 r biweekly	6	Symptom-free	Developed arth. right hand, hip, ankle, and both shoulders. Given 5 doses to these joints, with relief of symptoms
14	M 32	Gc. arth., right knee and shoulder	2	96 r biweekly	4	Symptom-free	Developed arth. ankles. Given 4 doses with relief
15	F 40	Gc. arth., right knee, acute	1	100 r biweekly	10	Improved	Had bone involvement
16	M 29	Gc. arth., right shoulder and elbow, left wrist, acute	3	88 r biweekly	4	Symptom-free	Elbow used as a control; grew worse, finally treated, but without relief. Joints originally treated cured
17	M 24	Gc. arth., left knee	1	80 r biweekly	8	Symptom-free	.....
18	M 60	Gc. arth., both ankles and feet, and left wrist	5	88 r biweekly	5	Symptom-free	.....
19	F 36	Gc. arth., left knee, acute	1	88 r	7	Improved	After fourth treatment gap of three weeks owing to an influenzal attack
20	M 24	Gc. arth., right knee, acute	1	80 r biweekly	8	Marked improvement	.....
21	M 30	Gc. arth., both knees, acute	2	100 r biweekly	8	Improved	Ankles involved later; relieved with similar treatment
22	M 35	Gc. arth., right knee and ankle, acute	2	100 r biweekly	4	Improved	Right wrist and temporomandibular joints involved and treated later, with relief
23	M 48	Gc. arth., both ankles and right shoulder, acute	3	80 r biweekly	5	Improved	Left knee later involved and treated with relief

TABLE III—(*continued*)

No.	Sex Age	Diagnosis	No. of Joints Involved	Dosage r in air	No. of Treatments	Result	Remarks
24	M 22	Gc. arth., right knee, acute	1	80 r biweekly	6	Marked improvement	.....
25	M 42	Gc. arth., right foot and ankle, acute	2	80 r biweekly	2	Slight improvement	Discharged before treatment finished
26	M 26	Gc. arth., ankles, knees, and lumbar spine, subacute	5	80 r (spine 120 r)	3	Marked improvement	.....
27	M 35	Gc. arth., right hip, acute	1	120 r biweekly	9	Marked improvement	Only one field each time
28	M 48	Gc. arth., left knee, acute	1	88 r biweekly	8	Marked improvement	Right knee later involved and treated with relief
29	M 40	Gc. arth., left ankle and right knee, acute	2	80 r biweekly	6	Marked improvement	Left knee later involved and treated without improvement
30	F 20	Gc. arth., left knee, acute	1	80 r biweekly	5	Improved	.....
		II. Non-gonorrheal					
31	M 32	Acute infectious arth., both knees	2	80 r biweekly	6	Symptom-free	.....
32	M ?	Acute infectious arth., ankle	1	80 r biweekly	3	Improved	.....
33	F 33	Acute infectious arth., knee	1	80 r biweekly	2	Unchanged	Later developed suppurative arth.
34	F 26	Acute infectious arth., ankle	1	88 r biweekly	6	Symptom-free	.....
35	M 46	Acute infectious arth., knees, ankles, and wrists	6	100 r biweekly	6	Marked improvement	.....
36	F 33	Acute infectious arth., hand	1	100 r biweekly	3	Marked improvement	.....
37	F 56	Acute infectious arth., hip and knee	2	88 r biweekly	5	Unimproved	.....
38	F ?	Acute infectious arth., hand and elbow	2	80 r biweekly	6	Unimproved	.....
39	F 46	Acute infectious arth., right knee	1	85 r biweekly	7	Slight improvement	Improvement not noted for some weeks
40	M 50	Chronic infectious arth., knees, ankles, and hand	5	80 r biweekly	3	Marked improvement	Treated at different dates; one recurrence
41	F 22	Chronic infectious arth., right hip	1	80 r biweekly	8	Marked improvement	Dramatic pain relief
42	M 30	Chronic infectious (?) arth., elbow	1	100 r biweekly	4	Unimproved	.....
43	F 56	Chronic hypertrophic arth., spine	...	200 r biweekly	4	Improved	Spine treated in two sections
44	F 56	Chronic hypertrophic arth., spine	...	150 r biweekly	4	Improved	.....
45	M 66	Chronic hypertrophic arth., spine	...	80 r biweekly	5	Marked improvement	.....
46	F 75	Chronic hypertrophic arth., spine	...	100 r biweekly	4	No record	.....
47	M 68	Chronic hypertrophic arth., spine	...	280 r weekly	2	Improved	.....
48	M 62	Chronic hypertrophic arth., spine	...	200 r biweekly	4	Slight improvement	.....
49	M 58	Chronic hypertrophic arth., shoulder and spine	...	80 r biweekly	7	Unimproved	.....

ments. In a few other cases, one out of three or four involved joints failed to respond; the majority of these were subacute or subchronic lesions. From this, we

gained the impression that the optimum time for roentgen therapy was in the really acute stage.

DISCUSSION

Gonorrheal arthritis is an extremely "labile" form of arthritis, many remedies being capable of producing rapid and more or less satisfactory results. However, the very number of remedies recommended, pyrotherapy, typhoid vaccine, omnadin, gonargin, and so forth, indicates that none is specific or certain in its action. At the moment, pyrotherapy, in one form or another, appears to be most popular. However, both this and non-specific protein therapy have such unpleasant by-effects, and are so much less easy to control, that we believe roentgen therapy is unquestionably superior.

Besides being contra-indicated in patients with cardiac disturbances, marked arteriosclerosis and nephritis, pyrotherapy appears to be more uncertain in its results than roentgen therapy. Atsatt (5) recommends for the treatment of gonorrheal arthritis that the patient's temperature be held "above 103.5 degrees F. for at least two to four hours"; Epstein (6), treating cases of syphilis and gonorrhea, used temperatures "between 102.2 and 104.9 degrees F. for six hours"; Desjardins (7) used temperatures of "106.5 degrees for five to eight hours." And all of these authors recommend from three to six such sessions of hyperpyrexia at relatively short intervals. In addition to these "ordeals by fire," Atsatt uses dilaudid, scopolamin, and other narcotics in connection with the therapy and urges that "the technician appear calm and self-assured" during the procedure.

However, the results of roentgen therapy are not sufficiently uniform to permit a feeling that it is the last word in therapy. As Desjardins remarks "the effect of radiotherapy is chiefly to relieve pain, and this effect appears to be induced indirectly by causing the resolution of inflammatory deposits which have not yet become organized. In some cases relief from pain is rapid. . . .in others it is partial and transient." Åkerlund (2) regards the effect of roentgen therapy in gonorrheal arthritis as "magical. . . after very few days all symptoms and signs were nearly gone." Westermark (8) reports that the end-results of roentgen therapy in a group of cases of gonorrheal arthritis of the hip are better than by any other method; he notes more rapid restoration of perfect function, fewer ankyloses, etc.

RESULTS IN CASES OF NON-GONORRHEAL ARTHRITIS

(*a*) *Acute Infectious* (*Unclassified*) *Arthritis.*—The number of cases in this and the subsequent groups is too small to permit of generalizations. However, the actual results are worth recording, as is our clinical impression that the method offers possibilities for much benefit if judiciously employed.

Nine cases of acute infectious arthritis, in which a total of 13 individual joints were involved, were treated. Four cases became free from symptoms, two were considerably improved, and three were not improved at all. In the series of cases treated, the joints involved included the ankles, knees, hips, elbows, and wrists. Eight of 13 joints, or 60 per cent, were improved. Absence of the immediate and often spectacular relief which occurs in cases of gonorrheal arthritis was conspicuous.

(*b*) *Chronic Infectious Arthritis.*—Three cases of chronic infectious arthritis, in which a total of ten individual joints were involved, were treated. Two cases became free of symptoms, and one was not improved at all. The joints involved (and treated) were similar to those in the acute infectious group.

(*c*) *Chronic Hypertrophic* (*Degenerative*) *Arthritis.*—Seven cases of chronic degenerative arthritis of the spine (spondylitis deformans) were treated. The ages of the patients ranged from 56 to 75. Only one case became free from symptoms, four cases improved, and one case was not improved at all. These cases really represent quite a different and much more difficult

problem than those of the previous groups. However, they are included here to permit comparison of the results obtainable with those observed in the other types treated. Definite osteophytic and posterior articulation changes were demonstrable in the roentgenograms. The one case which showed no improvement at all also had severe hypertrophic changes in the left shoulder joint; this joint did not improve either.

The good results reported in the literature in the treatment of chronic arthritis by x-rays are interesting (9, 10, 11, 12). Rohr (9) treated 40 cases after other methods had failed. About one-half of the cases were chronic infectious lesions and the remainder chronic degenerative. He found that small doses, about 20 per cent S.E.D., were more effective than large doses, such as 45 per cent S.E.D. He used large fields, in order to radiate the periarticular tissues as well as the joints themselves. The pain frequently began to decrease on the day after the first radiation treatment, and, later, such effusions as were present absorbed and the mobility of the joints improved. He noted that "young patients reacted better than older ones."

SUMMARY

Thirty cases of acute infectious (gonorrheal) arthritis were treated with small doses of x-rays delivered to the involved joints twice weekly for two or three weeks. Twenty-eight cases (93 per cent) were much improved and two (7 per cent) were unimproved. Approximately half of the improved cases appeared to be completely cured within a few weeks of the end of treatment; the rest improved gradually but, while free of pain, had some slight stiffness or disability in the involved joints. Five patients in whom joints were left untreated as controls showed no improvement in the untreated joints.

A small group of cases of non-gonorrheal arthritis was also treated. The results in this group, while gratifying, were neither as spectacular nor as convincing as in the gonorrheal group.

The author's thanks are due to Dr. A. J. Williams and the late Dr. W. L. Allred, without whose capable assistance and interest the major work of treating the patients described in this paper could not have been accomplished. He is also indebted to the staff of the various services at the San Francisco Hospital for their courtesy and co-operation in referring patients for treatment.

REFERENCES

(1) SOKOLOFF, W.: Roentgen Rays. Russky Vratch., 1897; also Fortschr. a. d. Geb. d. Röntgenstrahlen, 1898, **1,** 209.

(2) KAHLMETER, G., and ÅKERLUND, A.: The Roentgen Treatment of Arthritis. Acta med. Scandinav., 1930, supp. 34, pp. 19–28.

(3) WILLIAMS, F. H.: The Roentgen Rays in Medicine and Surgery. Macmillan Co., New York, 1901.

(4) ALLISON, N. A., and GHORMLEY, R. K.: Diagnosis in Joint Disease. William Wood & Co., New York, 1931.

(5) ATSATT, R., and PATTERSON, L.: Gonorrheal Arthritis: Its Treatment by Electropyrexia. Calif. and West. Med., 1935, **42,** 94.

(6) EPSTEIN, N.: Discussion of above paper.

(7) DESJARDINS, A. U.: Relative Value of Radiotherapy, etc., in Arthritic Disturbances. 1935 (to be published).

(8) WESTERMARK, N.: Roentgen Therapy of Gonorrheal Arthritis. Nord. med. tidskr., April 15, 1933, **5,** 453–456.

(9) ROHR, H. D.: Die Röntgenther. der chr. arthritiden. Strahlentherapie, 1931, **42,** 425.

(10) LANGER, H.: Roentgen Therapy in Arthritis: New Aspects and Technic. RADIOLOGY, February, 1933, **20,** 78–84.

(11) FRIED, CARL: Roentgen Therapy of Arthritis. Strahlentherapie, 1934, **49,** 634.

(12) VON PANNEWITZ, V.: Röntgendiagnose und Röntgentherapie der Arthritis. Verhandl. d. deutsch. orthop. Gesellsch., Kong., 1934, **28,** 112–118.

450 Sutter Street

EFFECT OF IRRADIATION OF THE PITUITARY IN DYSMENORRHEA[1]

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WE ARE well acquainted with the ability of large doses of x-rays or gamma rays to kill the ovarian follicles and so bring on the menopause. Follicles and corpora lutea will thereafter be absent from the ductless gland system. Small doses of radiation have also been applied to the pelvis with the hope of influencing the endocrine balance. Empirically undertaken, this has seemed to us and others to be at times of some benefit.

Disliking to subject young women to the menopause (big doses) and equally disliking to subject possible progeny to the danger of injury to the genetic apparatus (moderate doses), we gave up ten years ago such attempts to influence the endocrines by pelvic irradiation. However, with increasing evidence being published as to the control exercised by the pituitary upon the ovary, we desired to try irradiation of the pituitary. We realized that this would be empirical, would have a very uncertain theoretical foundation. We could hardly know for sure in any given case of menstrual dysfunction whether we should choose to lessen or to augment pituitary secretion. We doubted if the x-ray could have a true stimulating effect on secretion anyhow, but thought we might answer the question: "Does a given dose of x-ray to the pituitary produce any perceptible effect on (disturbed) hormonal function of the ovary?" We knew we should have to limit ourselves to small doses, that, at least until results could be promised, our patients would not put up with epilation.

[1] Read before the General Medicine Section of the California Medical Association at the sixty-fourth annual session, Yosemite National Park, May 13–16, 1935.

ANTERIOR PITUITARY SEX HORMONE IN THE BLOOD

EFFECT OF X-RAY TREATMENT OF THE PITUITARY

56 cases assayed

- 36 cases hormone not increased
  - 3 given x-ray all uninfluenced in amount of hormones
  - 33 not given x-ray (only one given "fake")

  → no cases of hormone increasing to abnormal level
- 20 cases excess hormone in the blood
  - 10 cases not given x-ray
  - 10 cases given x-ray

	Excess hormone persisted	Excess hormone disappeared
6 AMENORRHEA all unimproved	2	4
3 MENOPAUSE 2 improved 1 unimproved	1	1 1
1 DYSMENORRHEA improved		1
TOTAL	3	7

What we would have to measure would be the influence on symptoms. These are listed in the accompanying tables. When patients complained of several symptoms they are tabulated under each.

Most of the groups are presumably heterogeneous as to etiology or mechanism. This is unfortunate. We tried to homogenize the dysmenorrhea group by refusing (for this investigation) those cases which were obviously or probably due to pelvic inflammation, tumors, or gross physical abnormalities. Such "primary" or "idiopathic" cases are, of course, the very ones for whom we most need new therapeutic weapons. So, also, we avoided cases of bleeding possibly due to tumors. The amenorrhea cases were all functional (not due to surgery, radiation, pregnancy, or climacterium), and a few (13 per cent) had a diagnosis of neurasthenia or psychasthenia.

In all, 172 patients were accepted for pituitary irradiation. We had subsequently to throw out a number because they were not successfully followed. We also later decided to include only those of the private patients who were under Dr. Pettit's own care. The final number of patients tabulated was 110. We think the reduction was not selective, for we observe that, of the 24 matched cases not followed, 13 were in the group that had received radiation and 11 were of those from whom the x-ray had been screened off.

Of the 110, all were followed two months or longer, 39 less than six months and 19 longer than five years. No late roentgen injuries of any kind could be discovered and the only early injury was transient epilation in the first half-dozen treated, in whom the dose was 30 per cent higher than that given the rest of the cases.

TABLE I

DYSMENORRHEA 56 patients given 61 series of X ray to the pituitary.	PAIRED CASES		SUPP. SERIES RECEIVING X RAY	TOTAL THAT RECEIVED X RAY
	X ray leaded off	Received X ray		
CASES	15	26	20	46
IMPROVED	1. 33%*	73%	70%	2. 72%**
UNIMPROVED	3. 67%	27%	30%	4. 28%

*one case recurred after 3 months. **3 cases recurred after 3 mos., 1 after 1½ yrs.

Average follow-up for each class: 1 – 26 mos., 2 – 25 mos., 3 – 22 mos., 4 – 27 mos.

TABLE II

CASES	DYSMENORRHEA COMPLICATED BY	CONTROLS X ray leaded off		RECEIVED X RAY Total of cases in paired and supplementary series	
		Cases	Per cent. improved	Cases	Per cent. improved
13	Low metabolic rate. B. M. R. 9% minus or lower	5	0	8	75%
13	Infantile pelvic organs	2	0	11	82%

ROENTGEN TECHNIC

Treatments were given at 200 kv., 5 ma., 43 cm. distance, $^3/_4$ mm. copper plus 1 mm. aluminum, 16 minutes to 8 × 8 cm. area on each temple, yielding 110 roentgens (measured in air). (Our machine is very slow.) This was repeated in half dosage (8 minutes) weekly for five more sittings. In order to avoid completely any psychologic influence by patient or doctor, two treatment cones were prepared of identical weight and appearance, one labeled *A*, the other *B*. One of these had a lead sheet inserted between copper and aluminum filters, but none of us knew which one this was. Patients were assigned alternately to *A* and *B* courses. It became necessary later to prepare a similar cone, known to be without the lead sheet, so that certain patients could be accepted for "non-experimental treatment." These form a supplementary series, whom we knew to be getting x-ray at the time of their treatment. After 48 of the *A* and *B* patients had been treated, we looked at the cones with the fluoroscope to find which one transmitted x-rays. Soon after this the labels were removed, and the cones renumbered 1 and 2. Again none of us knew which was the blank one. Another series of matched cases was treated, totalling 98 cases, 49 with each cone. These cones were saved and after tabulating all the cases, five years after the last had been treated, we again looked with the fluoroscope to see which one transmitted x-rays.

It was explained to all these patients that we were trying the effect of two different filters. They understood that the matter was experimental. They were charged nothing for their treatments.

We observe that all this care was in some degree unnecessary, for the percentage of improvement is not very different among those getting x-ray, and known at the time to be getting it, from what it was among those getting the x-rays and we not knowing whether they were getting them or not. However, it does let us feel sure that differences in results are not attributable to our having discriminated (consciously or unconsciously) in regard

TABLE III

CASES	OTHER SYMPTOMS	CONTROLS X ray leaded off		RECEIVED X RAY Total of cases in paired and supplementary series	
		Cases	Per cent. improved	Cases	Per cent. improved
18	Total bleeding cases	4	0	14	29%
11	Menorrhagia	2	0	9	22%
7	Metrorrhagia	2	0	5	40%
65	Total irreg., scanty & absent mens.	23	39%	42	43%
22	Irregularity	10	40%	12	42%
12	Scanty menstruation	4	50%	8	37%
31	Amenorrhea	9	33%	22	45%
22	Menopausal symptoms	7	29%	15	67%
17	Frigidity	5	20%	12	33%
16	Sterility	6	0	10	10%

to the other therapy (not x-ray) given these patients.

We did note one definite psychological effect—even the clerks noticed it— namely, subjective improvement in most of the patients for the first two weeks, irrespective of which cone was being used.

Dr. F. C. Fluhmann assayed the blood of some of these patients for anterior pituitary sex hormone. His findings are summarized in Chart I. The necessary resolution into groups makes the numbers seem rather small, but we think there is definite indication that this hormonal function of the pituitary gland was influenced (diminished) by even these small doses of x-ray. We have set this out first because such objective evidence appeals as being more dependable than the subjective evidence of symptomatology.

The only definite symptomatic result came in dysmenorrhea, in which improvement was two to one among those getting x-ray, whereas among those getting no x-ray it was disimprovement two to one. The numbers seem large enough to be statistically significant and we have presented them in Table I.

We had basal metabolic readings on 52 patients and found 10 of the dysmenorrhea group with rates lower than 9 per cent minus. Three of these 10 patients received a second series of treatments, totalling 13 cases.

There were 22 patients with infantile pelvic organs. Only those complaining of dysmenorrhea seemed to improve under x-ray treatment.

Because a low basal metabolic rate and genital hypoplasia might mark out groups with endocrine disturbance, we have separated them from the dysmenorrhea cases in Table I and have shown them in Table II. The results look a little better than for the whole group, but the numbers are so small we cannot be sure of their significance.

We were often asked to try our pituitary x-ray treatment for symptoms other than dysmenorrhea. Such cases are presented

TABLE IV

NO X RAY	X RAY	NO X RAY	X RAY	X RAY	SYMPTOMS
* o	* o	—	—	—	Dysmenorrhea (irreg., frigid.)
* o	o	—	—	—	Amenorrhea (frigid.)
* o	* +	—	—	—	Dysmenorrhea (Amenorrhea)
* o	* +	—	—	—	Dysmenorrhea (frigid., sterile.)
* o	+	—	—	—	Dysmenorrhea
—	* o	* +	—	—	Amenorrhea (Irreg.)
—	+	* o	—	—	Dysmenorrhea (frigid., sterile.)
—	o	—	* o	—	Amenorrhea
—	o	—	o	—	Amenorrhea
—	* o	—	+	—	Menorrhagia
—	* +	—	o	—	Menopausal symptoms
—	* +	—	+	+	Menopausal symptoms

+ indicates that improvement followed the series. o indicates no improvement.
* Asterisk marks treatments given "blind" (without knowing whether X ray was reaching patient or not).

in Table III. Of all these, only menopausal symptoms seem to have responded appreciably to x-ray therapy.

Fourteen of our patients became pregnant, although only one of these had come complaining of sterility. We note that of the matched cases, five became pregnant after receiving x-ray therapy and five became pregnant after receiving no x-ray therapy.

Due to relapses or persistence of symptoms, 12 patients received more than one series. These occur in the tabulations once for each x-ray series given, and they are set forth in Table IV for closer study. We observe that four cases of dysmenorrhea had remained unimproved after a simulated treatment, only to improve later after x-ray was really given.

One case of amenorrhea improved after a simulated treatment, whereas it had resisted a real one. This example interests us because it illustrates the pitfalls of clinical observation which we designed our "matched case" technic to avoid.

CONCLUSIONS

Small doses of x-ray to the pituitary, 385 r (measured in air) directed to each temple, over a period of five weeks, have been followed by amelioration of dysmenorrhea in more than two thirds of a selected group of 56 patients.

Special technic of paired controls makes the evidence appear dependable.

Menopausal symptoms seem also to have been influenced favorably.

In regard to menorrhagia and metrorrhagia, the evidence is inconclusive.

Irregular, scanty, and absent menstruation, frigidity and sterility seem not to have been influenced.

An abnormal amount of anterior pituitary sex hormone in the blood was apparently reduced by irradiation of the pituitary.

BIBLIOGRAPHY

1. Ford, F. A., and Drips, D. G.: Clinical and Experimental Studies of Low Dosage Irradiation of Ovaries and Hypophysis in Menstrual Disorders. Radiology, 1929, **12,** 393–402.

2. Sahler, J.: Ueber die Ergebnisse der Hypophysenbestrahlung bei gynäkologischen Erkrankungen. Ztschr. f. Geburtsh. u. Gynäk., 1927, **92,** 25–45.

3. Huet, J. A.: La radiothérapie de l'hypophyse curatrice des troubles fonctionnels de la ménopause (33 observations). Bull. et mém. Soc. de radiol. med. de France, 1933, **21,** 561–564.

LOCALIZED PLEURAL EFFUSION ACCOMPANYING CONGESTIVE HEART FAILURE

REPORT OF TWO CASES

By E. L. SHIFLETT, M.D., Methodist Hospital, *Indianapolis, Indiana*

GENERALIZED pleural effusion accompanying congestive failure is observed frequently, but localized effusion associated with heart disease has not been emphasized in roentgen literature. Stewart, in 1929, Kiser, in 1929, and Steele, in 1932, have contributed case reports of this condition to heart journals. Freedman listed cardiac failure as a cause of encapsulated pleural effusion.

So far as we can determine, Stewart (1) recorded the first case. The patient, a female, aged 64 years, suffered four attacks of congestive heart failure over a period of fourteen and one-half months. During each attack an effusion localized to the interlobar space occurred; *during one seizure this was the only evidence of cardiac failure.* The effusion gradually disappeared with clinical improvement, but returned with subsequent attacks.

Kiser (2) contributed the second case. The clinical and roentgen findings paralleled those of Stewart's case. The effusion gradually decreased coincident with clinical improvement and had completely disappeared when the patient was dismissed symptom-free.

Steele (3) reported two cases. One had a pleural effusion localized to the interlobar space, and, in addition, bilateral basal congestion and obliteration of the right costophrenic sinus by a small amount of fluid or adhesive pleurisy. The effusion increased as symptoms became more severe; when compensation was restored, they regressed and finally disappeared. Steele's second case had had symptoms of heart trouble for two years. A roentgenogram secured at the time of the patient's first admission to the hospital showed a pleural effusion localized to the right upper lobe. A subsequent attack of congestive failure occurred eight years later and the effusion returned in the same location. This again disappeared when the patient became symptom-free.

Stewart and Steele have described autopsy findings in cases of localized pleural effusion accompanying heart disease. There is a generalized adhesive pleuritis of the parietal and visceral pleuræ which obliterates the entire pleural cavity, with the exception of the small spaces in which the fluid collects. These spaces are lined by relatively normal pleura or fibrous tissue. The adhesions are dense and fibrous, and the pleura is thickened; this thickened pleura may offer resistance to paracentesis. The fluid is a transudate, cultures of which have not revealed the presence of an organism which could be considered as the etiologic agent.

These autopsies have not revealed infectious or inflammatory processes sufficient to explain the pleurisy. Whether or not there has been an antedating inflammation terminating in adhesive pleuritis, or whether the pleuritis is a result of prolonged congestive heart failure, has not been definitely established by the cases reported. The pleuritis and obliteration are probably secondary to heart failure of long standing, and differ from the usual irregular strands of thickened pleura frequently observed in this type of case. The localizing character is determined mechanically by the small sacs formed between two layers of relatively normal pleura persisting in an otherwise obliterated cavity. It is essentially effusion of cardiac failure.

Since this is not a clinical entity, there are no characteristic symptoms; and because of the small amount, the localized effusion may not be detected by physical examination. The symptoms are those of congestive heart failure. It is important

Fig. 1.

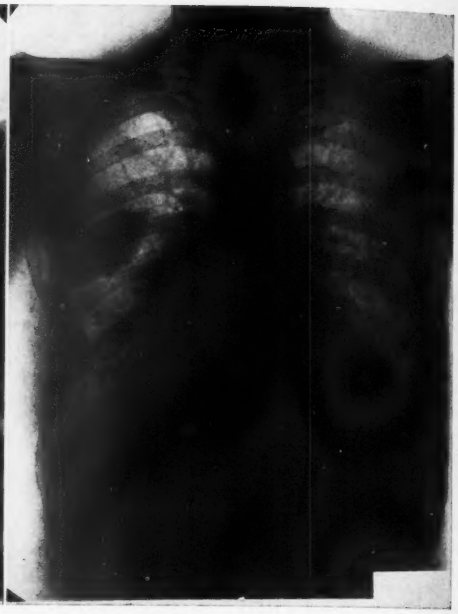

Fig. 2.

that the roentgenologist recognize the true significance of this type of pleurisy with effusion. It must be differentiated from all lesions of the pleura and lung which cause small isolated areas of increased density in the roentgenogram. Since patients suffering from heart failure and coronary occlusion frequently have fever, leukocytosis, cough, and chest pain, it is particularly necessary that one shall not diagnose these as empyemas. Occasionally they may simulate metastatic nodules; one of our cases with effusion had been considered probably metastatic by the attending physician.

There are certain characteristics which aid in diagnosis. The effusion is usually sharply localized to the interlobar fissure or to one lobe, and has occurred on the right side in all cases reported. The heart is usually enlarged and the chest may show evidence of congestion, edema, fibrosis, and generalized thickening of the pleura. The fluid gradually disappears with recovered compensation, but may recur at the same location with subsequent attacks.

Although the following cases have not been confirmed by autopsies, the clinical course, physical findings, and roentgen evidence establish, in our opinion, a diagnosis of localized pleural effusion of congestive heart failure.

Case 1. Male, aged 60 years, was admitted complaining of weakness, dyspnea, and nocturnal orthopnea of several months' duration. These symptoms had gradually increased in severity. At first, relief was obtained by bed rest alone, but because of the increasing severity of symptoms he was admitted to the hospital. He did not give a history of infectious diseases preceding his heart trouble. There was no history of important familial diseases. Physical examination showed a well-developed and well-nourished male. The eyes, ears, nose, and throat were normal. Venous congestion was present, and visible pulsations were observed in the neck. He was cyanotic and quite short of breath. There was moisture in both pulmonary bases. The heart rate was 110, and gallop rhythm was present. Systolic blood pressure was 178; diastolic pressure, 108. The heart sounds were of poor quality. The

heart was enlarged downward and to the left, and there was slight abdominal distention and engorgement of the liver. There was no edema of the ankles. X-ray showed pleural effusion localized to the interlobar space, and a large heart (Fig. 1).

The clinical diagnosis was congestive heart failure. The patient was treated with morphine, small doses of digitalis, and bed rest. He was markedly improved when he was dismissed from the hospital. A follow-up roentgenogram of the chest was not obtained.

Case 2. Male, aged 72 years, had had high blood pressure for several years. Six months before admission to the hospital he had suffered from orthopnea, dyspnea, and weakness. He had noticed moderate edema of the ankles. He had never suffered cardiac pain. An x-ray made in the clinician's office showed a localized pleural

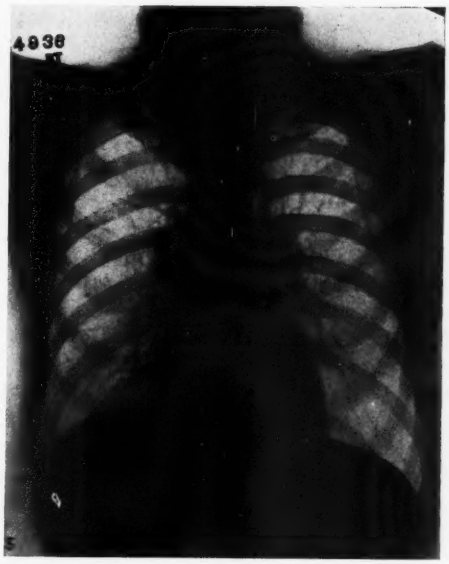

Fig. 4.

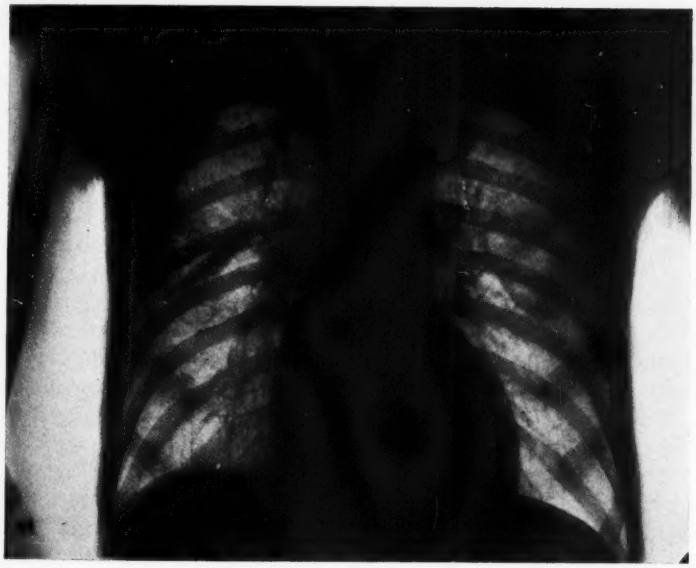

Fig. 3.

effusion on the right side, and an enlarged heart (Fig. 2). He was treated in a private office for these symptoms, and there was gradual improvement. He was admitted to the hospital on Nov. 2, 1934, because of urinary symptoms. At this time he complained of burning, painful and frequent micturition, and was suffering from a paradoxical incontinence. His first urinary symptom had been noted ten years before admission. There was no history of past diseases of importance.

Physical examination showed a well developed and well nourished male. The sensorium was cloudy, and it was necessary to use a restraining sheet to keep him in bed. The eyes, ears, nose, and throat were negative; mouth edentulous; tongue coated, and chest negative. By percussion the heart was not enlarged. No murmurs were detected. Blood pressure, 220/80. There was some swelling of the feet and ankles. The bladder was distended and reached to the umbilicus. The urine was cloudy. The prostate was small, smooth, and hard, but was confined to the capsule. Pulse rate, 88; respiration, 20; temperature, 97.8.

Laboratory examination showed a straw-colored, cloudy urine of alkaline reaction, and a specific gravity of 1.008. A slight trace of albumen, an occasional pus cell, and a rare blood cell were found. The patient received general treatment in preparation for prostatic resection, which was performed on Dec. 26, 1934. The post-operative course was good. Although he did not receive digitalis, the dyspnea, orthopnea, and edema gradually disappeared with bed rest and general urologic treatment. Roentgenograms made during the course of preparation showed a gradual disappearance of the localized effusion paralleling the clinical improvement (Fig. 3). He was entirely free of cardiac symptoms on dismissal, and was urinating freely. Chest roentgenograms made at this time showed no evidence of the effusion, and a normal sized heart (Fig. 4). It has been reported to us that this patient has suffered recurrent attacks of failure since dismissal, but we have not been able to secure a roentgenogram of the chest during one of these attacks.

REFERENCES

(1) STEWART, H. J.: Pleural Effusion Localized in an Interlobar Space. Am. Heart Jour., 1928–1929, **4**, 227.

(2) KISER, E. F.: Pleural Effusion Associated with Congestive Heart Failure Localized in an Interlobar Space. Am. Heart Jour., 1928–1929, **4**, 481.

(3) STEELE, J. MURRAY: A Report of Two Cases of Localized Pleural Effusion in Heart Failure. Am. Heart Jour., 1931–1932, **7**, 212.

(4) FREEDMAN, E.: Roentgenological Appearance of Interlobar and Mediastinal Encapsulated Effusion in the Thorax. RADIOLOGY, 1931, **16**, 14.

BLOOD CHANGES IN PATIENTS HAVING CARCINOMA OF THE CERVIX OF THE UTERUS IRRADIATED WITH A 300,000-VOLT ROENTGEN APPARATUS[1]

REPORT OF NINE CASES

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CHANGES in the blood associated with radiation therapy have attracted considerable attention during the past twenty years. In 1920, Siegel (1), in an extensive article, described the blood changes occurring after radiation. Bosch (2) reported in detail the blood changes which occurred in patients irradiated by the single dose method of Seitz and Wintz. He also reviewed the literature and noted the differences in the observations of investigators. Lack of uniformity as to the part of the body irradiated, and in the factors of treatment, etc., may account for these variations. In 1920, Seitz and Wintz (3) stated that irradiation of the pelvis in cases of carcinoma of the cervix of the uterus sometimes produced permanent blood changes, and in some of these cases may have accelerated death.

Schubert (4) used 500,000 and 600,000 volts in radiating the pelvis for malignant diseases of the female generative organs. He found that the percentage of hemoglobin was usually unchanged, the number of red blood cells was slightly decreased, and an absolute leukopenia with a relative lymphopenia was constant in all patients. The white blood cell count fell occasionally as low as 2,000. This marked leukopenia resulted in no harmful consequences.

Lavedan (5), also, studied the blood changes occurring in patients having carcinoma of the cervix of the uterus irradiated with a technic similar to the one employed by us. The only variation was in the voltage, which was 200,000. He noted that the amount of hemoglobin and number of red blood cells remained stationary or decreased moderately. The white blood cell count always decreased before the third week of treatment, sometimes dropping to 2,250. The decrease was due in greater part to a relative lymphopenia, occasionally as low as 6 per cent. The blood usually became normal within two months after the last treatment. Lavedan called attention to four cases in which a marked relative lymphocytosis, of 40 to 50 per cent, was found several months after the termination of radiation. This was considerably higher than before treatment. All of these patients were well for more than five years. In contrast, two patients with a persistent leukocytosis and an increase of polymorphonuclear cells during irradiation died shortly after conclusion of treatment. The persistent leukocytosis is interpreted as indicating infection. He (Lavedan) refers to Regaud's observation that infected neoplasms react less favorably to radiation.

In the routine blood examinations made during the course of radiation therapy with the 300,000-volt roentgen apparatus at the Morrisania City Hospital, changes were noted which aroused our concern, especially as regards the safety of supplementary radium therapy or additional roentgen therapy in the presence of leukopenia. In the hope that others might be stimulated to investigate this matter, this preliminary report of our observations is presented. Patients with blood dyscrasias were not included in this study. To minimize error, only patients suffering from the same disease (carcinoma of the cervix of the uterus) were studied. However, the anatomic extent of the disease differed in the various cases. The blood was taken several hours after meals, at

[1] Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

the same hour of the morning or afternoon, and always before treatment. The hemoglobin was measured by the Sahli method. Most of the patients received both intra-uterine and vaginal radium, usually after the termination of roentgen irradiation. Lavedan has shown that this form of radium therapy usually has little or no effect on the blood. We have accepted this fact in the interpretation of our data. The pelvis was irradiated through the following portals: one anterior; one sacral, and two gluteal. In four of the earlier cases, lateral pelvic fields were also employed. The portals varied from 10 × 10 to 15 × 15 cm.; in one case the portal was 20 × 20 cm. The dosage per field varied from 75 to 150 r. Two or three portals were irradiated, either in one or two daily séances. The 300,000-volt tube, fixed at a distance of 80 cm., is operated at 4 ma., with a filter of 2 mm. Cu, plus 1 mm. Al, plus wood. The output is about 5 r per minute, measured in air. The dose delivered at a depth of 10 cm. is about 48 per cent of the skin dose. The total dose administered about the pelvis varied from 6,300 r to 10,000 r (in air), and the course of treatments extended over periods of from 35 to 75 days.

Case 1. W. F., aged 36 years, had advanced carcinoma of the cervix, with infection of the neoplasm.

Roentgen therapy was as follows: 7,500 r in 35 days (30 treatment days) to five fields 10 × 15 to 15 × 15 cm., 150–300 r in two daily séances. Vaginal radium (1,900 mgm.-hr.) was given between the roentgen treatments.

The hemoglobin, which was 60 per cent before irradiation, reached 74 per cent three weeks after the last treatment, with the aid of a 500 c.c. blood transfusion. The white blood cell count was slightly over 20,000 before treatment, due most probably to the badly infected carcinoma. During the course of treatment, the number of white cells steadily decreased and was still low three weeks after treatment. Unfortunately, this patient left the city and no further blood examinations could be made.

Case 2. C. F., aged 46 years, was bleeding profusely from an ulcerated carcinoma of the cervical stump, but the hemorrhage stopped shortly after external radiation was begun.

Roentgen therapy was as follows: 6,500 r in 38 days (30 treatment days) to five fields 20 × 20 cm., 140–280 r once daily. Radon gold seeds (1,200 mc.-hr.) were inserted into a nodule in the posterior vaginal fornix three months after completion of roentgen therapy.

The hemoglobin was 80 per cent on admission and dropped to 60 per cent during treatment. Eighteen months after the last treatment it was almost 90 per cent. The number of white blood cells fluctuated but never descended to a very low figure. Examination made eighteen months after treatment showed a count slightly below that before radiation. The lymphocyte count dropped and rose with that of the total white blood cells, and several times was as low as 10 per cent. The last examination showed the percentage of lymphocytes to be well above the pre-radiation figure. If Lavedan's postulate is true, this patient should have a good prognosis. The blood showed no more evidence of radiation damage in this patient treated once daily, than in Case 1, treated twice daily, all other radiation factors being similar.

Case 3. W. F., aged 47 years, was admitted, with marked vaginal bleeding.

Roentgen therapy was as follows: 10,000 r in 15 + 54 days[2] (51 treatment days) to five fields 12 × 12 to 15 × 15 cm., 150–200 r in one and two daily séances. Intra-uterine radium (2,500 mgm.-hr.) was given immediately following roentgen therapy.

The first hemoglobin was 40 per cent of normal. After two 500 c.c. blood transfusions, the hemoglobin rose to 73 per cent. The patient then developed a thrombo-

[2] A total of 69 days—15 days before thrombophlebitis developed and 54 days after recovery from the phlebitis.

phlebitis of the thigh, and radiation therapy was suspended for six weeks. Six months after the last treatment, the hemoglobin was 80 per cent. The number of white blood cells was nearly 11,000 before radiation, dropped to 6,000, and then returned to 10,000, when the phlebitis was noted. Although the white blood cells dropped to 4,000 one month after radiation was started again, examination six months after the last treatment showed them to number 7,000.

Case 4. W. F., aged 45 years, was admitted because of profuse hemorrhage from an ulcerated carcinoma of the cervix.

Roentgen therapy was as follows: 7,500 r in 50 days (36 treatment days) to four fields 8 × 12 to 12 × 12 cm., 150–200 r in two daily séances. Intra-uterine radium (3,000 mgm.-hr.) was given between roentgen treatments. Vaginal radium (2,150 mgm.-hr.) was given immediately following these.

The first hemoglobin measured 48 per cent of normal. With roentgen therapy and one 500 c.c. blood transfusion, the hemoglobin rose to 60 per cent. Six weeks after the last treatment the hemoglobin was 78 per cent. There were 11,000 white blood cells at the start of treatment; they dropped very rapidly and remained around 3,000 for several weeks, but increased to nearly 7,000 six weeks after the last treatment.

Case 5. W. F., aged 36 years, had marked bleeding from the vagina when admitted.

Roentgen therapy was as follows: 7,775 r in 42 days (32 treatment days) to four fields 10 × 12 to 12 × 15 cm., 200–300 r once daily. Both intra-uterine (3,000 mgm.-hr.) and vaginal radium (4,500 mgm.-hr.) were used immediately following the roentgen therapy.

The hemoglobin measured 55 per cent on admission. Roentgen therapy was given, and with the aid of a 500 c.c. blood transfusion the hemoglobin very quickly ascended to more than 80 per cent. There were 3,200 white blood cells one week after the first treatment (unfortunately a count was omitted before radiation was started). Three weeks later the number descended to 1,850. This patient was not radiated for two days and then showed a count of 2,750. The white blood cells increased to more than 6,000 two weeks after the last treatment. The fall and rise in the lymphocytes was parallel to that of the total white blood cells. The hemoglobin and red blood cells showed no evidence of damage even though the patient was treated only once daily.

Case 6. W. F., aged 43 years, was bleeding profusely from a very large carcinoma of the cervix, and continued to bleed during most of the period of treatment.

Roentgen therapy was as follows: 6,300 r in 57 days (44 treatment days) to three fields 12 × 12 cm., 100–200 r in two daily séances. Radium, intra-uterine (2,250 mgm.-hr.) and vaginal (3,540 mgm.-hr.), was used immediately at the end of roentgen therapy.

With the aid of three transfusions, given at intervals during the irradiation, the hemoglobin, which at times receded to 42 per cent, reached 88 per cent four months after the last treatment. The number of white blood cells fluctuated considerably but returned to normal one month after the last treatment.

Case 7. W. F., aged 40 years, came into the hospital with the history of marked vaginal bleeding.

Roentgen therapy was as follows: 10,050 r in 77 days (63 treatment days) to four fields 10 × 10 to 12 × 12 cm., 150–200 r in two daily séances. Intra-uterine (2,900 mgm.-hr.) and vaginal radium (2,400 mgm.-hr.) were given immediately upon termination of the roentgen therapy.

The hemoglobin was 60 per cent on admission but dropped to 42 per cent two weeks after the first roentgen treatment. A transfusion of 500 c.c. blood was given before irradiation, and two transfusions were given during the course of irradiation. The hemoglobin rose rapidly to 80 per cent. Four months after the last treatment it was almost 90 per cent. The number of

white blood cells dropped moderately and was 5,000 four months after the last treatment.

Case 8. W. F., age 44, had, in addition to carcinoma of cervix, serologic evidence of syphilis and large uterine fibroids.

Roentgen therapy was as follows: 6,700 r in 35 days (30 treatment days) to five fields 12 × 12 to 15 × 15 cm., 200–300 r in two daily séances. Intra-uterine radium (2,500 mgm.-hr.) was used in this patient immediately at the end of roentgen therapy.

The per cent hemoglobin (70 per cent) remained stationary during irradiation but receded somewhat three weeks after its termination. The number of white blood cells (6,200) decreased sharply soon after treatment was started, and fluctuated during the remainder of therapy; three weeks after treatment it was 4,500.

Case 9. W. F., aged 38 years, had developed carcinoma of the cervix during the later months of pregnancy. Dr. Aranow, gynecologist of the hospital, coagulated the cervical neoplasm with endothermy and then performed a Porro cesarean operation in the eighth month of gravidity.

Roentgen therapy 6,170 r in 59 days (42 treatment days) to three fields 12 × 15 to 15 × 15 cm., 150 r once daily. No radium was given to this patient.

The white blood cells showed little change. The hemoglobin rose steadily, and with the aid of a 500 c.c. blood transfusion reached 100 per cent six months after the last treatment.

In this case, we see the effect on the blood of irradiation where no evidence of carcinoma could be found. The effect of carcinoma itself on the blood is difficult to estimate. Renaud (6), among others, believes that when blood changes occur in untreated carcinoma patients, a complication such as infection is usually present.

SUMMARY

(1) Patients with carcinoma of the cervix of the uterus, treated with a 300,000-volt roentgen apparatus with the technic and dosage described above, show no evidence of permanent blood damage.

(2) The percentage of hemoglobin and number of red blood cells may fall somewhat during a course of irradiation but usually returns to or even exceeds the level observed before irradiation. Patients with a quantity of hemoglobin as low as 40 to 50 per cent of the normal, due to loss of blood from an ulcerated lesion of the cervix, begin to show an increase in hemoglobin within a few weeks after the beginning of irradiation, with the aid of one or more transfusions.

(3) The total number of white blood cells drops in most cases as early as the second week after the beginning of treatment; thereafter, the trend is irregular. The lowest limits reached are far below those expected in untreated cases: in one patient the number was as low as 1,850. At no time was it necessary to suspend the treatment because of leukopenia. Within a few weeks after the last treatment the white blood cells increase, but usually not quite to the number before irradiation.

(4) The drop in the number of white blood cells is due to a decrease of all the cellular elements. In three cases in which the data were available, a lymphopenia, both relative and absolute, was present. The number of lymphocytes always increases after the cessation of treatment.

(5) The number of cases is too small and the time which has elapsed since irradiation is too short to show whether there is any prognostic value in the observed blood changes.

REFERENCES

(1) Siegel, P. W.: Strahlentherapie, 1920, **11**, 62.
(2) Bosch, Hans: Strahlentherapie, 1932, **45**, 503.
(3) Seitz, L., and Wintz, H.: Unsere Methode der Röntgentiefentherapie und Erfolge. Urban & Schwarzenberg, 1920.
(4) v. Schubert, E.: Strahlentherapie, 1932, **44**, 293.
(5) Lavedan, J.: Arch. de l'Institut du Radium de l'Université de Paris et de la Fondation Curie, 1932, **2**, 457.
(6) Renaud, C.: Bull. Assn. franç. p. l'étude du Cancer, 1923, **12**, 79.

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PATHOLOGICAL RARITIES IN CANCER[1]

TWO UNUSUAL CASES

By ANGELO M. SALA, M.D., Pathologist, New York City Cancer Institute

AS OUR contribution to this symposium, we wish to put on record two unusual cases which have recently come to autopsy. In both instances, only the postmortem examination supplied the correct diagnosis.

GELATINOUS CARCINOMA OF THE DUODENUM

Case 1. The patient, K. U., a colored female, 59 years of age, was sent to us from another hospital on Jan. 21, 1935, with a clinical diagnosis of carcinoma of the stomach with liver metastases. In August, 1934, she had begun to experience cramp-like pains following meals, attended by nausea, a feeling of fullness, belching, and occasional vomiting of undigested food. Symptomatic treatment relieved her until October, 1934, at which time all her symptoms returned with an additional feeling of substernal pressure after eating. She complained of all these things on admission to our hospital, as well as a loss of 50 pounds in the previous five months. She had never vomited "coffee-ground" material. There was no jaundice, nor did she have unnatural stools.

On physical examination, the liver was felt an inch below the navel, apparently not nodular. No other masses were made out. Roentgen-ray studies of the gastrointestinal tract showed, in the main, dilatation and stasis of the duodenal cap, and stasis and deformity of the descending duodenum. The conclusion was as follows: "Extra-gastric pressure, with deformity of the pylorus and descending duodenum, probably due to a pancreatic tumor." Laboratory examinations, including blood Wassermann and Kahn tests, were negative.

Operation was decided upon and done on Feb. 4, 1935.

Operative Procedure (*Dr. Braham Golden*).—"A right paraumbilical incision was made about six inches long. On opening the abdomen, a large elevation presented itself in the middle of the wound, the summit of which consisted of omentum and small gut, apparently the third portion of the duodenum. The elevation on exploration proved to be caused by a huge mid-line hard nodular mass, apparently retroperitoneal and pushing forward most of the adjacent structures. The second portion of the duodenum was found somewhat dilated, evidently by reason of outside pressure. The stomach was small and pushed upward under the liver by the mass. Digital exploration of the tumor through the foramen of Winslow showed huge encapsulated nodular masses, probably lymph nodes, in the lesser omentum behind the stomach. A small nodule, apparently a lymph node of neoplastic consistency, was removed."

The surgeon's post-operative diagnosis was retroperitoneal lymphosarcoma. Unfortunately we could neither prove nor disprove this impression, because the small lymph node removed at operation proved to be the seat of only a moderate hyperplasia. Death occurred on Feb. 9, 1935, and an autopsy was done about four hours after death.

Autopsy Findings (*Dr. Sala and Dr. Elma Barany*).—The hilus nodes were all found markedly enlarged, dull gray in color, firm in consistency, with softening and commencing necrosis at the center. The lungs were generally edematous. The operative incision was clean; the peritoneum was glistening; there was no fluid. The stomach was markedly dilated. The fundus of the gall bladder was adherent to the duodenum and hepatic flexure of the colon. There was felt a huge retroperitoneal mass in the region of the pancreas,

[1] Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

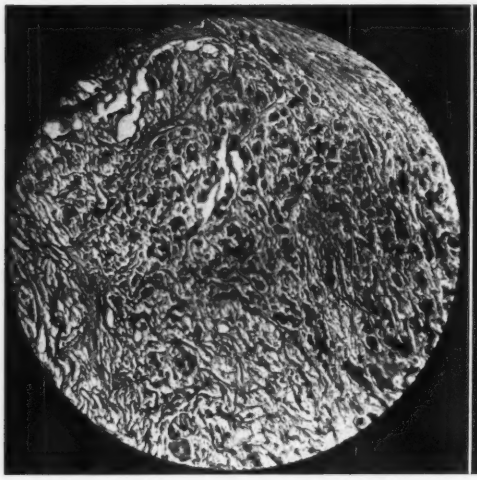

Fig. 1.

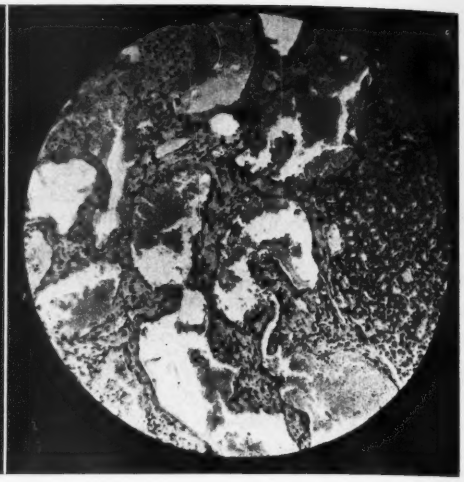

Fig. 2.

which pushes forward the stomach and gut. The liver was removed; it weighed 1,965 gms., and was moderately congested, but otherwise negative. The bile ducts were natural. Examination now disclosed a huge enlargement of the retroperitoneal nodes, which, in the region of the pancreas, by close contact without matting together, had formed a mass the size of a large orange. This mass of nodes was very adherent to the stomach and duodenum, and was removed with them, along with part of the jejunum. Careful inspection disclosed no lesion in the stomach or supra-ampullary and ampullary portions of the duodenum. The infra-ampullary duodenum, however, was found to be the seat of a large ulcer 5 cm. in diameter, with hard rolled edges, inextricably adherent to, and resting upon, the head of the pancreas and the mass of nodes. The remainder of the intestinal tract was removed and opened: no lesion was found anywhere. The mesentery was negative. The retroperitoneal nodes along the aorta, over the sacrum, and in the pelvis were all markedly enlarged, discrete, and on cross-section appeared like the hilus nodes already noted. The pancreas itself appeared negative on careful examination. Other findings were negative.

The anatomical diagnosis was lymphosarcoma, and the duodenal ulceration was considered to have resulted from pressure. We were greatly surprised by the microscopic examination, which showed a gelatinous adenocarcinoma (Fig. 1), with metastases to the lymph nodes mentioned. In view of the autopsy findings, and the thorough examination of the whole gastro-intestinal tract, it must be concluded that we have here a case of gelatinous carcinoma of the infra-ampullary duodenum, with extensive lymph node metastases.

The lesion is uncommon enough to justify putting all observed cases on record. For those interested in the literature of the subject, we append reference to two articles, both of which refer in turn to other papers. We feel that in this case there is no way of proving or disproving whether or not a duodenal ulcer preceded the carcinoma. We ourselves have yet to be convinced that gastric or duodenal carcinoma ever arises from an ulcer.

A CASE OF EXTENSIVE HEMANGIOMA OF THE LIVER

Case 2. The patient, J. G., a colored male, 59 years of age, was sent to us from another hospital with a diagnosis of sarcoma of the liver. Shortly before 1932, he

had begun to have vague complaints of indigestion, with constipation. In 1932, he had noticed a gradual enlargement of the abdomen. That same year a laparotomy had been performed at a third hospital, and his family was told that he had an inoperable tumor of the liver. At this operation no liver tissue was excised for microscopic examination. He came to us on Jan. 22, 1935, in a markedly poor condition, complaining chiefly of indigestion, nausea, vomiting, and marked constipation. On physical examination there was felt a huge mass occupying three-fourths of the abdominal cavity, apparently arising from the liver and of a doughy consistency, being cystic in places. The lower edge of the mass was felt about one inch above Poupart's ligament. There was no clinical jaundice. Icteric index was 20. Serological tests for syphilis were negative. He was put on custodial care with purely symptomatic treatment. The course was progressively downhill and the patient died on Feb. 6, 1935. Autopsy was done a few hours after death.

Only the appearance of the liver will be detailed here: the other findings were unimportant beyond an extensive lobular pneumonia, with pulmonary edema as the immediate cause of death. The huge mass palpated clinically proved to be the liver, which weighed 6,570 grams. It occupied the right half of the abdomen down to the pelvis; on the left side it extended over to the left hypochondrium. Surface inspection of the liver gave about the same appearance as that of a polycystic kidney. The cut surface showed wellnigh complete transformation of the liver substance into a mosaic arrangement of large blood-filled spaces and areas of hemorrhage, separated from one another by thin fibrous septa. Only scattered small islands of liver tissue could be detected in the right lobe; more liver tissue was present in the left lobe, but here also the predominating picture was that of blood-filled spaces and areas of hemorrhage. Gall bladder and bile ducts were negative.

The histologic picture of numerous areas of the liver was uniformly that of hemangioma. Histologic evidences of malignancy were everywhere lacking (Fig. 2). Several retroperitoneal and pelvic lymph nodes, found enlarged at autopsy, all proved on microscopic examination to be the seat of inflammatory and not neoplastic changes.

REFERENCES

1. DAVIS, C. R.: Carcinoma of the Duodenum. Am. Jour. Cancer, 1935, **23**, 337.
2. WILSON, J. A., and NOBLE, J. F.: An Instance of Gelatinous Carcinoma of the Duodenum. Am. Jour. Digest Dis. and Nutrition, 1935, **1**, 840.

XANTHOMATOSIS[1]

A CASE OF SCHÜLLER-CHRISTIAN'S DISEASE TREATED BY IRRADIATION

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THERE is a group of diseases characterized by a primary constitutional disturbance of lipoid metabolism which leads to an overflow of lipoid substances in the blood and tissues. In an effort to rid the blood of excess lipoids, certain cells of the reticulo-endothelial and histiocytic systems ingest and store these fats, with the result that storage-cell tumors are formed in the various bones and organs of the body.

The presence of these tumors in bone causes a local osteoporosis, due to direct pressure of the tumor on the trabeculæ. In soft tissues and organs, the lipoids infiltrate the parenchyma and interfere with the function of those organs. In addition, the presence of free lipoids in the tissues evokes an inflammatory cellular reaction as well as a secondary proliferation in the tissues, resulting in a fibrosis or a reaction similar to that produced by any foreign substance.

These three phenomena blend and constitute the typical lipoid granuloma or storage-cell tumor, the elements of which are varied only by the rapidity and location of the process.

These storage-cell tumors are sulphur yellow in color, fatty on section, and have a consistency of putty or soft rubber. Microscopically, they are composed of collections of large vacuolated cells each 20–80μ in diameter, and are often referred to as foam cells because of their resemblance to that bubbling substance. These vacuoles are due to the presence of fat droplets in the protoplasm, which in the process of laboratory preparation are dissolved out, leaving small vacant spaces. The cells simply act as small storehouses; they do not undergo division. When one cell is fully filled with fat, another joins the group and thus little tumors are gradually formed.

The clinical picture is also variable and depends upon the type of lipoid at fault, the acuteness of the process, and the location of the lipogranulomas.

On this basis five clinical entities are recognized:

(1) Gaucher's disease.
(2) Niemann-Pick's disease.
(3) Schüller-Christian's disease.
(4) Skin types associated with or without diabetes, icterus, and pregnancy.
(5) Essential xanthomatosis.

The basic lesion in all of these conditions is the lipoid granuloma, but the type of lipoid at fault and its distribution is what determines the clinical course. Rowland has coined the name "xanthomatosis" for this group of fundamentally related conditions.

The first three groups affect the skeletal system to a greater or lesser degree, and are, therefore, of special concern to us in this review.

Groups 4 and 5 do not affect the skeletal system, and comprise xanthomatous deposits occurring in the skin, tendon sheaths, aponeuroses, or joint capsules. These conditions are benign and may be associated with icterus, diabetes, or pregnancy. Occasionally, neoplasms or inflammatory processes undergo xanthomatous degeneration.

(1) *Gaucher's Disease.*—Gaucher, in 1882, described a condition subsequently identified with his name in a thesis entitled "Epitheliome primitive de la rate, hypertrophie idiopathique de la rate, sans leucemie."

Kerasin, a phosphorus-free cerebroside, is the lipoid at fault. This disease may occur at any age (the oldest case reported

[1] Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

was 56 years of age), but usually in female children, and occasionally in sisters. The spleen shows a gradual enlargement, followed by an enlargement of the liver. Pain is usually present in the upper left abdomen due to a perisplenitis. The left kidney gives evidence of dysfunction due to pressure from the spleen. The skin on the exposed parts (face and hands) becomes bronzed.

The blood shows an anemia of a chlorotic type. A moderate leukopenia and, later in the disease, a thrombopenia are present and result in epistaxis and metrorrhagia. Pain in the ribs and long bones is an evidence of bone marrow involvement. The patient may show a considerable emaciation, but the abdomen still remains large, due to the increase in size of the spleen and liver. The superficial glands are rarely involved.

The disease runs a chronic and benign course in adults, but is more acute in children. Death usually results from some intercurrent infection.

Pathologic findings show that typical foam-cell granulomas are present in the spleen and bone marrow. The Gaucher cell is 20–80μ in diameter. Polymorphous single or multiple nuclei are placed near the cell border. Under high magnification, the cytoplasm appears wrinkled rather than foamy, showing an irregular network like spider web. It stains light blue with Mallory's stain, with acid-fuchsin, anilin-blue-orange G., with previous fixation with picric acid and ammoninin bichromate.

In the bone marrow the cells are elongated, spindle-shaped, reveal sharp striations, and occur in bundles. The liver is cirrhotic, but without hypertrophy of the bile ducts. The internal lymph glands are hypertrophied.

Bone involvement is less frequent, but an osseous form has been described by Pick. In the latter, the participation of the organs may be altered so that it predominantly involves the bones. In the flat bones, the spongiosa is filled with a yellow or gray tissue which occurs in diffuse or speckled form. In the long bones, nodules form which may fill the marrow cavity.

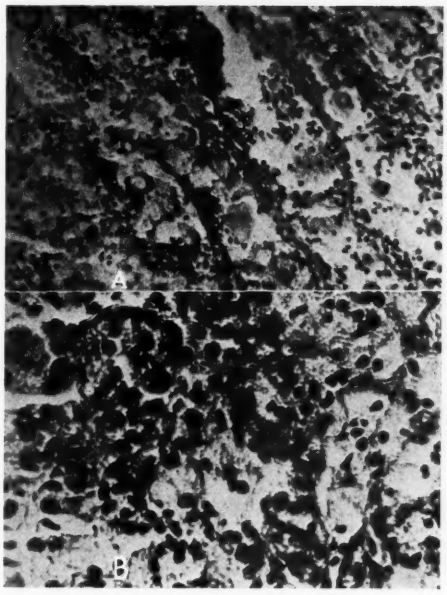


Fig. 1. Foam cells in a case of Schüller-Christian's disease (after Rowland). *A* (upper). Low power. *B* (lower). High power.

On roentgen study, the bones appear less opaque and are coarse-grained and worm-eaten. The cancellous bone may show large defects and thinning of the cortex without osteoplastic changes.

The cause of the lipoidosis is unknown. There are other diseases in which an excess amount of fat is present in the blood stream, *e.g.*, diabetes, yet there is no tendency on the part of the fixed tissue cells to ingest and store this fat. This seems to indicate that there must exist a constitutional predisposition on the part of the reticuloendothelial cells in the individuals affected, to take up this fat. Furthermore, the preponderance of such cases amongst individuals of the Jewish race and often in members of the same family fortifies the opinion of a constitutional disturbance. Whether this disturbance is purely metabolic or associated with a disturbed excretory mechanism, is still to be determined.

The lipoids are stored in cells of the retic-

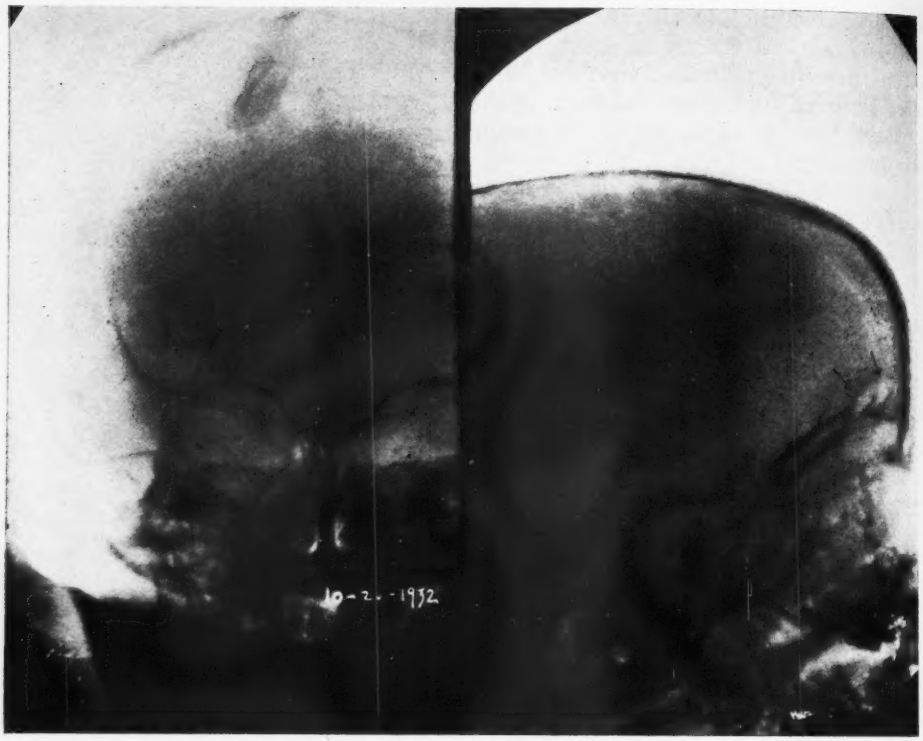


Fig. 2. Circumscribed area of rarefaction, involving the frontal bone and roof of the right orbit. The lump present at this site was removed a few days later and sectioned for microscopic study (October, 1932).

ulo-endothelial system. These cells are present in the spleen, liver, bone marrow, and lymph glands. In the spleen, the cells are derived from the reticulum of the pulp, malpighian corpuscles, and adventitia of the arterioles. In the liver, they are derived from the cells of Kupffer and the clasmatocytes of Glisson's capsule. The reticulum cells of the lymph nodes and bone marrow are the other sources.

(2) *Niemann-Pick's Disease.*—This condition was originally recognized in 1914, by Niemann, who reported an unknown disease picture in a 17-month-old child. It occurs primarily in Jewish infants and proves rapidly fatal. The phosphatid lecithin, a lipoid normally occurring in the body in cellular walls and in nervous tissue mainly, becomes stored in abnormal amounts in the liver, spleen, and other organs. The bone marrow is but slightly infiltrated, although a skeletal form has been described. The symptoms are similar to those in Gaucher's disease, but are more intense, due to the rapid course of the disease and the wide distribution of the lipoids. The reticulo-endothelial cells are rapidly saturated with the lipoids, following which other tissue cells are forced to store the fats. This results in an overwhelming infiltration with lipoids of practically every organ and tissue of the body. A secondary reaction, similar to a foreign body reaction and fibrosis, occurs in the various organs, and mechanically interferes with the vital functions of those organs. This failure and cachexia eventually result in death before two years.

The marked dyspnea and cyanosis present in these cases are due to interference with respiratory function by secondary fibrosis in the lung parenchyma. The liver

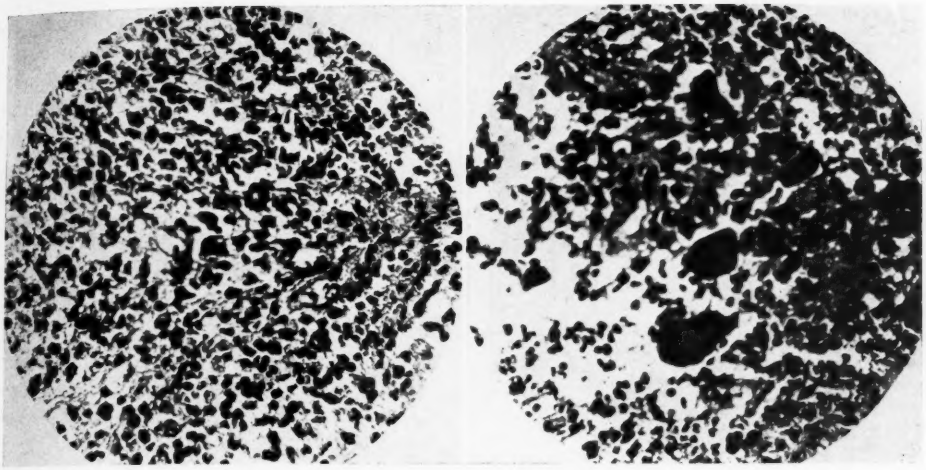


Fig. 3. Section of biopsy taken from the lump on the forehead, four months after onset of symptoms and before any irradiation was given. The tissue is very cellular, contains many giant cells, some fibroblasts, and resembles osteitis fibrosis.
Fig. 4. Same as Figure 3, high power.

and spleen are enormously enlarged and actually determine the size of the abdomen. The lymph nodes are enlarged. The skin is yellowish, due to the intense lipemia, but foam cells are never found in the circulation. Occasional leukocytosis or leukopenia is present.

The diagnosis is usually established by splenic puncture, which demonstrates the presence of foam cells. These are usually smaller than the Gaucher cell.

Pathologic examination shows all organs and tissues saturated with lipoids; they are yellowish in appearance, and indurated, due to the presence of replacement fibrosis.

(3) *Schüller-Christian Disease.*—In 1893, Alfred Hand described a case of polyuria associated with tuberculosis in a child, aged three years and six months. Exophthalmos was present, and large defects in the cranial bones filled with a sulphur yellow material were found on postmortem examination. He attributed these findings to tuberculosis. In 1921, after reading the reports of Schüller and Christian, he recalled that the case he described in 1893 possessed the syndromic triad of what we now know as Schüller-Christian's disease.

In 1915, Schüller, of Vienna, described two cases, one in a boy of 16 and another in a girl of four years and six months, each of whom showed exophthalmos, diabetes insipidus, and defects in the cranial bones. In addition, the presence of infantile genitals, and panniculus adiposus in the older child led him to assume that the disease was due to a disturbance in the function of the hypophysis.

In 1919, Christian reported another case possessing the same cardinal symptoms in a girl five years old, and inferred from observation of the case over a period of six months that the condition was probably due to a metabolic disturbance. He was able to influence the polyuria by hypodermic administration of pituitary.

In 1928, Rowland's monumental work on the subject gave us the first lucid explanation of the pathologic processes involved and their causal relations to the symptoms; the etiology, however, still remains obscure. It is now agreed that Schüller-Christian's disease is a constitutional disorder of metabolism, with a deposition of cholesterol and its esters leading to a characteristic hyperplastic reaction in the reticulo-endothelial or histiocytic apparatus.

Fig. 5. C. E., now 3 years and six months old. Note exophthalmos and depression of the right eye (August, 1934). The prominence of the right forehead is due to the presence of a storage-cell tumor.

In this disease there is a marked involvement of the skull bones and occasionally of other bones, and it may, therefore, be considered as the osseous form of xanthomatosis.

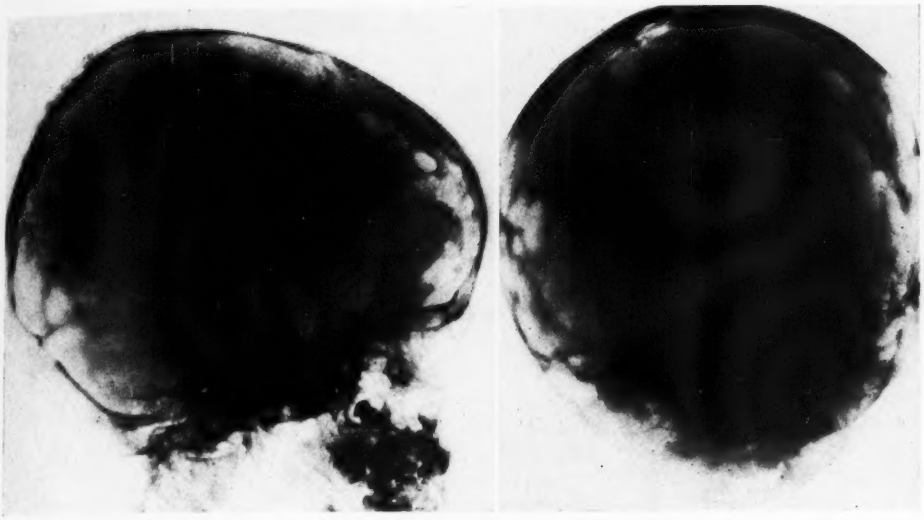
Children are most often affected but the disease may appear during adolescent or adult periods. It is more common in males. The symptoms and pathology vary with different stages of development and with the age period of the patient. The childhood form is most frequent. There is usually a history of good health up to the time of onset. The common childhood diseases may have been present, with prolonged convalescence.

The appearance of a lump on the head, with the demonstration of cranial defects by roentgen examination, is usually the first and most constant symptom. Exophthalmos and diabetes insipidus are usually present and together with the cranial defects constitute the syndrome. In the early stages of the disease, a number of lesser symptoms such as gingivitis, loose teeth, and vague pain may be present. Dwarfism, cessation of growth, failure to gain weight, mental retardation, and adiposogenitalis dystrophy are secondary to glandular lipoidosis and are less frequently present. As the symptoms are directly related to the pathologic infiltration of the involved organs with lipoids, the appearance of referable symptoms will depend on such involvement if and when it should occur.

There is no regular sequence for the appearance of the symptoms and many need not be present. In the case herewith reported, the symptoms of diabetes insipidus are still lacking, although almost three years have elapsed since the onset. Nevertheless, the symptoms may be progressive and the child become dyspneic and cyanotic. In fatal terminations, death usually occurs in from two to four years as a result of dyspnea, cardiac failure, and anemia. In the adolescent form the condition is more protracted, the symptoms are fewer at first, growth retardation is more prominent, and the bone defects progress at a slower pace. Periods of remission are present. Life may last from five to twenty-five years. The adult type is rare and protracted. The symptoms are those of a true polyglandular syndrome. Arrest of development and mental retardation are pronounced. The bone defects resemble osteitis deformans.

As revealed by Rowland, the pathologic processes have a definite relation to the symptoms. A mass of foam cells or histiocytes loaded with fat appear in the tissues surrounding small blood vessels. These masses gradually become larger, forming granuloma-like nodules, arising from dense connective tissue. The process may be more diffuse and involve many tissues and organs, or a marked fibrosis or a foreign body giant-cell reaction may take place. These changes blend and intermingle.

In bone, the lesions may be circumscribed or diffuse. An eosinophilic infiltration with hemorrhage and necrosis may be present. The bone trabeculæ atrophy, due to pressure from the growth of foam cells. Repair and replacement occur by newformed spongiosa, with occasional osteoid or cartilaginous tissue. If the periosteum is not affected, new bone may develop therefrom. The bone is demineralized and cuts like cheese. Histologically, the bone



Figs. 6-*A* and 6-*B*. Patient C. E., roentgenograms of the skull taken 22 months later than that shown in Figure 2. Note the extensive and irregular areas of rarefaction involving mainly the frontal, parietal, and temporal bones. Smaller defects may be seen in occipital region. An island of uninvolved bone is present in the right frontal area. The right sphenoidal fissure is obliterated, indicating involvement of the right sphenoidal wings.

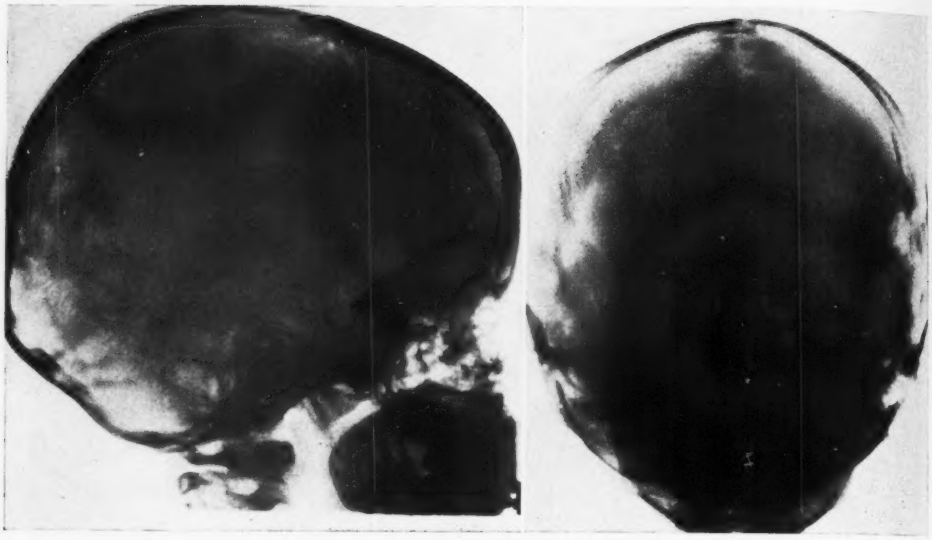
lesions resemble osteitis fibrosa, and, in the adult type, osteitis deformans.

Changes in the skull are of first importance. If two layers are involved, they are moth-eaten in appearance, but in the large defects involving three layers they are geographic in appearance. Any other bone in the body may be involved. If attempt at repair is present, the edges become blurred. In the adult type, the bone may even become thickened. These bone defects are due to a lipoidosis and not to any endocrine disturbance.

The exophthalmos is due to deposits in the orbit resulting in the formation of a fat pad behind the eyeball. Diabetes insipidus is due to a lipoidosis in the hypophysis. The sella turcica is involved in about one-third of the cases. If the disease involves a vertebra a compression fracture may occur, resulting in a kyphosis or gibbus. The intervertebral discs are never involved. The other glands, such as thymus, thyroid, pancreas, suprarenal, etc., if involved, will give a symptom-complex such as is usually produced by a functional disturbance of the gland. The blood picture shows an increased cholesterol content and may appear cloudy in acute cases.

Treatment.—Spontaneous remissions have been known to occur in several cases. Cignolini, in 1928, reported the successful utilization of roentgen therapy in Schüller-Christian's disease in a girl 14 years of age. The cranial defects disappeared completely. Sosman subsequently reported several other cases which he also successfully treated with roentgen rays. Some of these defects, however, are apt to recur. In the case herewith reported, roentgen rays were used with gratifying results. In cases in which the sella turcica is involved, the administration of roentgen rays will also improve the symptoms of diabetes insipidus.

Pituitary given hypodermically or as a nasal spray will control, although not cure, diabetes insipidus, but it has no effect on the disease proper. Insulin will control true diabetes and is useful in malnutrition. It will cause an increase in weight and improve the anemia, but has no effect on the disease. The various other endocrine substances and glandular extracts have been found wanting. It has been noted that a



Figs. 7-*A* and 7-*B*. Patient C. E., roentgenogram of skull six months after roentgen therapy. Many defects have completely disappeared, while others show partial healing. The superior ridge of the right orbit is considerably depressed and the diameter of the orbit is smaller than on the left. This probably accounts for the persistence of the exophthalmos even after the retrobulbar fat pads have been resorbed.

low blood cholesterol exists in cases of hyperthyroidism, and on that basis the use of thyroid extract has been suggested, but that, however, has not proved effective. A low fat diet appears logical, especially in view of the fact that lesions similar to those found in Schüller-Christian's disease have been produced experimentally with a high cholesterol diet. In practice, however, it has shown no influence. Other modifications in diet, administration of irradiated food, cod liver oil, liver extract, and high calcium diets were equally ineffectual in modifying the disease processes.

Prognosis.—The outlook is now considerably brighter than heretofore anticipated. One of Schüller's cases is well after 20 years. Christian's case of a 5-year-old girl, reported in 1919, is well after 16 years.

Of Rowland's 14 cases, seven are still alive. Sosman reported nine additional cases and seven of these are still alive. The older the individual, the better the prognosis. It appears that a certain tolerance is acquired as the child grows older, or that the provocative lesion heals and disappears. Therefore, if these vere early stage can be tided over, the prognosis is good.

CASE REPORT

C. E., Jewish, female, 19 months old, was referred on Sept. 20, 1932, complaining of a lump situated just above the outer portion of the right orbit. The mass was one-half inch in diameter, semi-hard, painless, and adherent to the underlying bone. There was a slight ptosis of the right upper eyelid. There were no other complaints.

The child was born on Jan. 4, 1931, at full term, normal delivery, and weighed seven pounds. She was breast-fed to nine months and walked at ten months. The teeth appeared at normal intervals. At five months she had chicken pox, and subsequently had occasional colds from which she fully recovered. There is one sister (seven years older) who is well, and her parents are well.

Three months before admission (16 months of age), the mother noticed a slight drooping of the right eyelid. Several weeks later, a small lump appeared on the forehead at the upper and outer border of

the right orbit. This lump slowly increased in size until Sept. 20, 1932, when it was one-half inch in diameter. Roentgen examination of the skull at the time revealed a round, sharply demarcated, rarefied area about one-half inch in diameter in the right frontal bone, involving the upper and external rim of the right orbit.

Five weeks later, on Oct. 26, 1932, another roentgen examination showed the rarefied area to have increased in size to about three-quarters inch. The mass on the forehead was also larger but the ptosis of the right eyelid remained about the same. There was no exophthalmos, polydipsia, or polyuria. A presumptive diagnosis of xanthomatosis of the Schüller-Christian type was made.

Surgical removal of the mass was advised and carried out a few days later. The pathologic report follows.

Microscopic findings reveal a very cellular tissue closely resembling that of an epulis. There are very many giant cells of the epulis type, some large, others quite small. The other cells have a scanty cell body and round or oval vesicular nuclei. In the periphery, some fibrosis is noted and there is a mingling of some fibroblasts and lymphatic cells with those described above. Nowhere are any lipoid-containing cells present. There is no evidence to classify the lesion with anything but the bone marrow hyperplasia occurring in parathyroid disease.

The child was thereafter occasionally seen by the family physician, who noticed the reappearance of the mass on the right forehead four months after removal (two years of age), and the presence of a slight exophthalmos of the right eye.

The child was again seen on May 8, 1934 (three years six months old), at which time the most pronounced change was in the appearance of the right eye. The right eyeball was pushed forward, downward, and medially. The palpebral fissure was widened, but the child was able to close her eyelids. The mass on the forehead had reappeared and was now fairly large and flat. Palpation of the scalp revealed several other flat irregular defects in the parietal and temporal regions. The edges of these defects were sharp and resistant, like the rim of a glass. A slight rhythmic diffuse pulsation was palpable over the temporal defects. There was no pain on slight pressure (deep pressure was avoided).

X-ray examination of the skull showed marked changes. There was a large area of rarefaction in the right frontal bone, beginning at the mid-line and extending above the right orbit to coalesce with another rarefied area in the right temporal bone. The frontal process of the right malar bone was completely destroyed. Several other large rarefied areas were present in the left temporal and occipital regions. The edges of these defects were sharp and there was no evidence of any new bone reaction.

The periosteum was elevated in several places producing an undulating surface. The entire thickness of the right temporal bone was involved. These findings are typical of the geographical skull of Schüller-Christian's disease. The bones of the chest, trunk, and extremities were not involved.

During June and July, 1934, roentgen therapy was administered to the parathyroids, using two portals, 200 kv., 4 ma., 40 cm. distance, 0.5 mm. Cu and 1 mm. Al filtration for a total of 3,440 r units divided in 8 weekly treatments. These treatments, however, failed to affect the cranial defects. In fact they grew larger, as revealed by a roentgen study made six weeks later.

The child was admitted to the hospital on Aug. 28, 1934, for further study. She also complained at this time of an occasional nocturnal headache, which was not confined to any particular place in the head. Exophthalmos of the right eye was present. There was no polydipsia, polyuria, or soreness of the mouth. The child was well nourished, fair skin and hair, weighed 39 pounds, and was 39.5 inches tall. The scalp was irregular in contour, and several sharp-edged defects were palpable in the frontal and temporal regions. The fontanelles were closed. The eyegrounds were normal and there was no disturbance of vision. The pupils reacted normally. The mouth was normal. The lungs and heart

were normal. The liver and spleen were not enlarged. Neurologic examination was negative except for the loss of the right plantar reflex. Blood pressure was 74 systolic, 45 diastolic.

The roentgen findings at this time showed, in addition to the skull involvement, a rarefied area the size of a nickel in the left ilium.

The fluid intake and output were as follows:

	Intake		Total	Output		Total
	Day	Night		Day	Night	
8/30/34	24 oz.	18 oz.	42 oz.	8 oz.	7 oz.	15 oz.
8/31/34	30	18	48	15	22	37
9/1/34	42	18	60	45	14.5	59.5
9/2/34	34	18	52	20	6.5	26.5
9/3/34	21	15	36	20	10	30
9/4/34	29	15	44	15	4	19

The total intake was never more than 60 oz. in 24 hours, and the output never more than 59.5 ounces.

Urine Examination

Mosenthal:	8	10	12	2	4	6	8	Night	Average
Spec. grav.	1.001	1.006	1.003	1.010	1.006	1.006	1.001	1.010	1.005
Amt. c.c.	500	300	325	50	200	200	75	450	2100

At other times the specific gravity varied between 1.015 and 1.027.

Bence-Jones albumin—negative.
Aschheim-Zondek test—negative.
Chlorides 1.56 grams/100 c.c. as NaCl.
P. S. P. 1st hour 35. 2nd hour 25. Total 60.

Blood Examination (Sept. 4, 1934)

R. B. C. 5,250,000 Platelets 520,000 W. B. C. 4,800 Hb.85%
Nyelocytes 0 Staff forms 2 Segmented forms 51
Lymphocytes 39% Monocytes 5% Eosinophiles 3%
Histiocytes were not found.

Blood chemistry	*8/30/32*	*2/19/35*
Glucose	100	74
Chlorides	520	530
Creatinin	1.26	1.2
Uric acid	4.6	4.7
Calcium	17	12.2
Total fats	755	1165
Cholesterol	200	217
Cholesterol esters	132	150
Phosphorus (whole blood)	38.8	35
Phosphorus inorganic	5.2	5.4
Total acid sol. phosphates	23	20
Lipoid phosphates as lecithin	412	372
Lipoid phosphates	16.7	14.5
Albumin	4.8	4.9
Globulin	1.5	1.6
Urea nitrogen	11.1	11
Non-protein nitrogen	25	25

The figures in the second column were obtained five months after the irradiation of the head and pelvis. Calcium was unusually high when the bone defects were greatest, and this might be accounted for by the presence of active bone absorption during that period. It returned to a high normal following irradiation, when recalcification was in progress.

Treatment.—Roentgen therapy was administered to the head, using four ports 140 kv., 4 ma., 40 cm. distance, and 3 mm. Al filter; 600 r units to the frontal and occipital regions. The pelvis received 400 r units in divided doses, using 180 kv., 4 ma., 40 cm. distance, 0.5 mm. Cu, and 1 mm. Al filtration. Epilation began in three weeks, and the hair returned in ten weeks.

The defects in the cranial bones began to

recede in about four weeks and continued to do so, as revealed by repeated roentgen studies, until the improvement is now about 90 per cent. Many of the skull defects have completely disappeared and have been replaced by what appears to be normal bone. There are still several incompletely healed defects in the temporal and occipital regions and in the right wings of the sphenoid.

In the healing of the defects about the right orbit, the superior margin formed by the frontal bone has been depressed, resulting in a decrease in the vertical diameter of the orbit. Likewise, there has been a slight narrowing of the orbit due to a thickening of the frontal process of the malar bone. The orbit is, therefore, considerably smaller than the one on the unaffected side and too small for the proper recession of its contained eyeball. The depression of the superior margin also prevents the eyeball from reaching the level of the normal eye. This, we believe, is in a great measure responsible for the persistence of the exophthalmos even after other symptoms have either disappeared or improved. The defect in the left ilium has healed.

In addition to irradiation, the child was given cod liver oil, powdered liver, and a high calcium diet, but we do not think that these exerted any influence on the course of the disease.

SUMMARY

A case of Schüller-Christian's disease in a Jewish girl, with onset at 16 months of age, is herewith reported. Drooping of the right eyelid, followed by a small lump on the forehead, were the first signs presented. Roentgen examination revealed a circumscribed defect at the site of the lump. Biopsy of the tumor revealed an osteitis fibrosa without the presence of foam cells. This fibrosis occurred early in the disease without the influence of radiation. There was no evidence of diabetes insipidus or other lesser symptoms. The child was next observed after an interval of two years, when the cranial defects and exophthalmos were markedly aggravated, but polydipsia and polyuria had not appeared. Roentgen therapy applied to the parathyroids did not seem to retard the progressive development of the cranial defects. Roentgen therapy was instituted over the bone lesions with gratifying results. At present, 90 per cent of the defects have disappeared. Exophthalmos, although somewhat improved, is still persistent. This, we believe, is in a great measure due to a constriction of the orbit, the result of a hyperplastic deposit of new bone at the site of the defects. Other dietary and glandular therapies did not influence the disease. The child has continued to develop mentally and physically at a normal rate.

We wish to express our appreciation for the valuable co-operation given by Dr. Mendel Jacobi, Director of Laboratories at the Beth El Hospital.

CONCLUSION

Cranial and other bone defects present in Schüller-Christian's disease can be definitely controlled and healed by irradiation of the lesions. The lipogranulomas cause a softening, spreading, distortion, and deformity of the bones involved, and these deformities become permanent when the processes of repair heal the defects. This is the reason for the persistence of the exophthalmos, if the bones forming the orbit have been extensively involved. The orbit becomes too small for the proper accommodation of the eyeball. It is, therefore, important that radiation therapy be instituted as early as possible, for the smaller the defects, the less the resultant distortion. If the disease can be recognized and therapy instituted before the eyeball has been displaced, exophthalmos would in all probability be avoided. Just how radiation influences the disease is not known. It probably affects the phagocytic properties of the reticulo-endothelialc ells, preventing the storage of lipoids and their formation of lipogranulomas and permitting healing processes to function. As the various symptoms are directly caused by the storage of lipoids and the presence of lipogra-

nulomas, the prevention of such storage is the prevention of resultant symptoms. There is no evidence to indicate that radiation will prevent or alter the lipoidemia.

BIBLIOGRAPHY

1. CHAMBERLAIN, E. N.: The Effect of Insulin and Other Endocrine Extracts on the Cholesterol Content of Tissues. Jour. Physiol., December, 1930, **70,** 441.

2. CHRISTIAN, H. A.: Contributions to Medical and Biological Research. Paul B. Hoeber, Inc., New York, 1919, **1,** 390.

3. CIGNOLINI, P.: Effetti locali e generali della radioterapia in un caso di diabete insipido associato ad osteopatia. Radiol. Med., January, 1929, **16,** 16.

4. EPSTEIN, EMIL, and LORENZ, KARL: Die Phosphatidzellverfettung der Milz bei Niemann-Pickscher Krankheit verglichen mit der Lipoidchemie des Morbus Gaucher und der Schüller-Christianschen Krankheit. Ztschr. f. physiol. Chem., 1930, **192,** 145.

5. JENNY, ERNST: Beitrag zur Kenntnis der Varianten der Gaucherschen und Niemann-Pickscher Krankheit. Weida i Thür., 1930, Thomas Hubert.

6. FRIMANN-DAHL, J., and FORSBERG, R.: Xanthomatosis with Defects in the Cranial Bones. Acta Radiologica, 1931, **12,** 255.

7. HAND, A.: Polyuria and Tuberculosis. Arch. Pediat., 1893, **10,** 673.

8. IDEM: Defects of Membranous Bones, Exophthalmos, and Polyuria in Childhood; Is it Dyspituitarism? Am. Jour. Med. Sci., October, 1921, **162,** 509.

9. PICK, LUDWIG: Niemann-Pick's Disease and Other Forms of So-called Xanthomatosis. Am. Jour. Med. Sci., 1933, **185,** 601.

10. IDEM: Classification of the Diseases of Lipoid Metabolism and Gaucher's Disease. Am. Jour. Med. Sci., 1933, **185,** 453.

11. IDEM: Über die lipoidzellige Splenohepatamegalie Typus Niemann-Pick als Stoffwechselerkrankung. Med. Clinic, September, 1927, **39,** 1483.

12. POHLE, E. A.: The Effect of Roentgen Rays on the Reticulo-endothelial System. Am. Jour. Roentgenol. and Rad. Ther., November, 1929, **22,** 439.

13. ROWLAND, RUSSEL S.: Xanthomatosis and the Reticulo-endothelial System. Arch. Int. Med., November, 1928, **42,** 611.

14. IDEM: Schüller-Christian's Disease. Am. Jour. Roentgenol. and Rad. Ther., November, 1933, **30,** 649.

15. SCHÜLLER, A.: Ueber einigartige Schadeldefekte in Jagendalter. Fortsch. a. d. Geb. d. Röntgenstrahlen, 1915, **23,** 12.

16. SOSMAN, M. C.: Xanthomatosis (Schüller'-Christian's Syndrome). Am. Jour. Roentgenol. and Rad. Ther., June, 1930, **23,** 581.

17. IDEM: Xanthomatosis (Schüller-Christian's Disease; Lipoid Histiocytosis). Jour. Am. Med. Assn., Jan. 9, 1932, **99,** 110.

SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM[1]

(Second Installment)

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., *Chicago*

AN IMPORTANT MICHIGAN FLUOROSCOPIC FOREIGN BODY CASE

IN the following case, tried twice, four radiologists of good experience and standing testified as experts, all agreeing that, from the records and everything they could learn, there was no liability; however, the jury, because they did not and could not understand, found for the plaintiff in both trials. This case is so important that it is reported in detail.

In 1926 the plaintiff, a man of 42, more or less addicted to the use of alcoholics, according to the testimony, got a small fragment of a needle in the sole of one of his feet. He went to the defendant physician, who, finding the foreign object in a roentgenogram which he made, tried to localize it and remove it under fluoroscopic (cryptoscopic) control. Some time afterward the plaintiff went to a hospital conducted by the State and there, after a diagnosis of dry gangrene, had the foot and leg amputated. The surgeon who did the amputation did so on the alleged diagnosis of a third degree roentgen dermatitis.

Roentgenograms made of the amputated limb showed calcific deposits in both anterior and posterior tibial and dorsalis pedis arteries, and the pathologist's microscopic diagnosis was Monckeberg's fatty degeneration of the middle layers of the arteries (the so-called corduroy artery), with marked calcium deposit in both the tibial arteries and the dorsal artery of the foot. The pathologic examination and report were by the late Aldred Scott Warthin.

Suit was brought against the physician and, considering the importance of the case, after I had been in consultation with the defendant's attorneys, it was decided advisable to take not only another roentgenologist along as a witness, but also a pathologist to testify regarding the character of the arteriosclerosis found in the amputated leg.

All the testimony agreed that the dorsum of the foot only had been exposed to the x-rays and that the ulcer or alleged x-ray injury had occurred on the plantar surface of the foot, in and around the operative incision.

The hospital history (as given by plaintiff, of course) reads as follows: "G. C., age 42. Last July patient ran a needle into left foot at base of great toe. X-rayed and operated without success. Twelve days later repeated under fluoroscope . . . needle not found but fluoroscope used for four hours. One week later burn began to develop *on sole of foot.*

"Dr. C. . . . examined foot and advised amputation. Amputated left leg below knee.

"Pathological Diagnosis: *Area of dry gangrene.* Marked Monckeberg calcification of arteries. Secondary pyogenic infection. Ulceration. Diffuse fibrosis. Report on bone later. After decalcification, no osteomyelitis found. Fibrosis of periosteum. Osteoporosis of bone. No active process.

(Signed) A. S. WARTHIN."

The late lamented P. M. Hickey, M.D., was put on the stand and, after qualifying, testified as follows:

Q. Will you please tell the jury how you measure the x-ray current—the strength of the x-ray current?

A. The strength of the x-ray current is measured by a meter which registers the

[1] The Editor desires to state that the questions and answers herein are transcriptions of court reporter's notes and have to be printed in form as received, without normal punctuation or phrasing. As printed, they serve to show the nature of court testimony although they do violence to grammatical rules.

quantity of current which goes through the x-ray tube. The measure of that is told in thousandths of an ampere, technically called a milliampere.

Q. So the strength is so many milliamperes? *A.* Yes, sir.

Q. How do you measure the time of exposure with reference to the milliamperes?

A. We measure it in milliampere minutes or seconds.

Q. How do you compute the milliamperes in seconds?

A. It is computed by dividing the number of actual exposure minutes by the number of milliamperes which are being delivered in the tube.

Q. Very well. What is the anode of an x-ray?

A. The anode of an x-ray tube is what is commonly known as the target, which is a solid piece of metal, usually tungsten, which receives the electric current, known as the electrons, and the anode is the point in the tube at which the x-rays are generated or formed. The rays scatter from the anode like the light from a candle. There is a dark side and a lighted side of the anode. The x-rays radiate in every direction from the front half. The tube is a round glass globe containing the anode and the filament. This contains the cathode and the anode. About the 4th or 5th of February I had occasion to x-ray the plaintiff's foot. One of my assistants did the work under my direction. There was a piece of metal or foreign body near the joint of the great toe. I have used the fluoroscopic method of diagnosis a great deal. The x-ray is used for locating foreign bodies, bullets, pins, needles, etc., in the body; for the examination of bones as to whether broken or diseased; also for the examination of the chest—to determine the condition of the heart and the lungs, and also for the examination of the organs of digestion—the stomach and intestines. Yes, also for treatment.

Q. What, if you know, is the maximum safe period of exposure with unfiltered rays with the tube at a distance of ten or twelve inches from the member?

A. Well, I would like to know the quantity and what we call the voltage of the tube or equivalent spark gap.

Q. Say the current was of sufficient strength to make a picture clear enough that the head of a needle could be seen in the foot.

A. Well, do you speak of that as being on a plate or on a fluoroscopic screen?

Q. On a fluoroscopic screen.

A. The ordinary current we use for such an examination would be two to five milliamperes and have an equivalent spark gap of five inches and the length of time which it would be safe to use such a current would be from eight to twelve minutes, or, granting it was four milliamperes in current, that would be about 48 milliampere-minutes—the actual time by the clock would be from eight to twelve minutes.

Q. That is, 48 milliampere-minutes is equal to 8 minutes?

A. If you were using 4 milliamperes current, yes, sir.

Q. You say anything above that would be unsafe?

A. With the ordinary individual, yes.

Mr. F. The defendant objects because plaintiff's counsel has not stated in the question, the factors that the witness is assuming.

Mr. G. The witness has already stated the factors.

The Court. All right, let it stand.

(*Witness continuing*). By the ordinary individual I mean the one who has a normal skin and in the usual state of health.

Q. What do you mean by "cumulative exposure?"

A. I mean that if there has been an exposure of, say, 10 milliampere-minutes on one day that if there were 10 milliampere-minutes given the following day, it would be equivalent to a little less than 20 milliampere-minutes given in one day.

Q. And why is that, Doctor?

A. Because the effect of the x-ray persists for several days.

Q. Supposing that the operator used a 10-milliampere current with a 4-inch spark gap and used it for 10 milliampere-minutes

on Monday and again on Tuesday for the same length of time with the same current and spark gap and a week hence and again a week from then, you may state whether or not that would be a safe exposure. Would that illustrate the principle of cumulative exposure? *A.* Yes.

Q. You may state whether or not, Doctor, there is any safety precaution to be used regarding cumulative exposure and the distance in time between them in the use of the x-ray.

A. If there has been a full exposure on a given day, it is customary to wait for two or three weeks before giving the second exposure. If there has been only a fractional dose given on the first day, then the rest of the fractional dose could be given at any subsequent time. The effect of the x-rays stays on the person for some time.

Q. How many milliamperes current and what spark gap would be necessary to produce a picture of a foreign body in a person's foot that would be clear enough for you to see and diagnose?

Mr. C. The defendant objects on the grounds that he has not got all of the elements necessary on which to pass an opinion.

The Court. I don't know if he has or not. Maybe the witness can give an opinion.

Mr. C. I am raising the question.

The Court. We will leave it to the witness.

The Witness. Your honor, I would like to ask if the use of "picture" means the film or fluoroscope?

Mr. G. I mean the fluoroscope.

A. The clearness of the fluoroscopic image depends upon the clearness of the individual's eyes. If you should attempt to make a fluoroscopic examination in this room, you could use a tremendous amount of current and not get a correct image, because your eyes are influenced by the light from the window. It takes at least fifteen or twenty minutes' preparation of the eyes so that they become sensitive, to sense the very slight shades of the fluoroscope.

Q. Assuming that the room is dark with only the light from the anode and cathode burning and the eye has been accustomed to the light of the room as would ordinarily be the case where the operator is trying to get an efficient picture on the fluoroscope.

Mr. C. We have the same objection.

The Court. If he can answer the question, he may.

A. You want the quality of the current?

Q. Yes.

A. Ordinarily, we use about four or five inch spark gap, that measures the voltage or the intensity of the current and not the quantity. The quantity of the current would be measured by milliamperes which would be from three to five milliamperes and the tube distance (by that I mean the distance of the target of the tube from the screen), the fluoroscope screen, I would say twelve to fifteen inches—that ought to give a clear image of either a hand or foot.

Q. Will you tell us the difference between accumulative exposure and continuous exposure?

A. Accumulative exposure is equivalent to the actual number of minutes the x-ray was on the part examined. A continuous exposure for a certain length of time is the same as the same amount of exposure after deducting the intermissions in which the current was cut off.

Q. About what is the time between an exposure to the x-ray of four to five milliampere current and the time when an erythema or burn appears?

A. We sometimes have at the end of 24 hours what is called the first appearance of redness which is usually quite short. The true erythema or redness usually comes on between the tenth and the fourteenth day, sometimes as late as the eighteenth day.

Mr. C. Did I hear you say in 24 hours this appeared?

A. The primary or round erythema which does not appear in all cases. The burn usually makes its appearance along about the end of the second week. I have seen all kinds of x-ray burns, acute and chronic.

Q. Assuming that this plaintiff acciden-

tally ran a part of a needle approximately one-fourth inch in length into the bottom of his foot at the point just under the base of the great toe; that the plaintiff felt little inconvenience and drove a truck thereafter for about four days; that during the four days no pain was felt and no inflammation or swelling appeared; that the needle in the foot was felt only slightly when pressure was brought to bear upon it; that there was no noticeable break in the skin at the place of the entry and the plaintiff wore his shoe and sock and continued about his work in the usual manner for the four-day period between Sunday and Thursday night; that on Friday about 9:30 in the morning plaintiff consulted the defendant, a physician; that defendant took two x-ray photographs of the injured member in an attempt to determine the location of the foreign body; that thereafter defendant made an incision in plaintiff's foot about one-half inch, under a local anesthetic; that the developed plate showed a good picture of the part and of the foreign body; that the defendant exposed the plaintiff's foot to the x-rays thereafter, using a fluoroscope, attempting to remove the needle for a period of two hours or so, alternated between the fluoroscope and another operating table without using the fluoroscope and that the wound was dressed and the plaintiff discharged; that the longest exposure on that occasion was approximately fifteen minutes and that there was more than one fifteen-minute exposure; that thereafter in approximately twelve or fourteen days the wound had healed to a large extent and had been during the time dressed every other day by the defendant; that there was no infection on the foot at any other place except at the point of incision; that the defendant pronounced the foot sufficiently healed to justify another attempt to locate and remove the needle; that at or about 9:30 in the morning on or about Sept. 18, 1925, the defendant injected a local anesthetic into the plaintiff's left foot and incised the foot on the top, between the great toe and the second toe; that the defendant attempted for approximately half an hour or less to remove the needle but failed; that at the time that defendant was using a tube stand and the rays of the machine were penetrating the patient's foot from the top with the tube approximately ten or twelve inches from the foot; that at about ten o'clock defendant placed plaintiff's foot under the x-ray using a Victor x-ray equipped with a Coolidge tube; that the rays were coming out of the opening from the center of the tube and that the rays were not filtered; that the tube was from eight to ten inches from the exposed member; that the defendant used a hand fluoroscope for a time; that the machine produced a clear picture of the foreign body, clear enough to enable a person to see the aperture in the head of the needle; that he continued to operate on plaintiff's foot for a period of about twenty minutes after which time he changed the position of plaintiff and placed the foot before another tube and about ten inches distant therefrom; that the plaintiff was at that time on what is known as a reclining table and his legs placed so that his foot was between the tube and the fluoroscope; that defendant attempted to get hold of the foreign body with surgical instruments continuously with frequent interruptions of between two to five minutes and one of about twenty minutes until approximately one o'clock in the afternoon; that plaintiff remained on the operating table without interruption with his left foot under the ray for a period of about three hours with the exception of intervals of a few minutes' duration as above stated; that during all this time there was no protecting medium on plaintiff's foot—you may state, Doctor, whether or not in your opinion the exposure of the plaintiff's foot to the x-ray in the manner indicated was proper or improper?

Mr. F. To which the defendant urges the previous objection: That the form of the question is improper; that the question lacks elements sufficient to scientifically answer the questions and, furthermore, the question is too long to be comprehended by the jury.

The Court. I notice that you used the words "Victor x-ray machine."

Mr. G. Fisher.

The Court. You said "Victor." I notice also you have in there, regarding the first day and a period of time stated wherein the current was on continuously for more than one period of twenty minutes. I don't believe that the evidence sustains that. Strike out of your question any references to any definite time on the first occasion and I will permit the Doctor to answer the question.

Mr. G. Consider the question as the court has suggested, eliminating any specific period of time on the first exposure.

The Court. On the first occasion the plaintiff visited the office of defendant.

Mr. C. We want the record to show that defendant objects to the amended question.

The Court. That is, your objection you stated, to this question may stand as the objection to the amended question?

Mr. C. Yes.

The Witness. Well, I think it is rather hard to do mental arithmetic problems as to the number of minutes the exposure actually took place. If you could summarize and give me the number of minutes they were, that the x-ray was actually applied, I would be glad to try to answer the question.

Q. Do you mean by summarized, the total time?

A. Yes, the question is too indefinite to give an answer.

Q. The question includes one period of constant exposure of twenty minutes, that is, time minutes. The evidence is clear, I think, as it can be, and that is the estimated time of the witnesses who saw the time and that estimate is all—an exposure of ten minutes and two to five minutes' rest and an interval of fifteen minutes and two to five minutes' rest and all the time during the whole period, the exposure was greater than the time the current was off.

The Court. That is on the last occasion?

Mr. G. Yes.

The Court. I will permit the Doctor to answer the question.

The Witness. Under the conditions of the question I will answer that the exposure was beyond the safe limit.

Q. Assuming then that after the expiration of one week from the time plaintiff was exposed in the manner indicated, the skin on the top and bottom of plaintiff's foot grew red and became inflamed and blisters or blebs appeared on the bottom; that the blisters or blebs were both large and small and contained a light colored serum; that the skin broke down and sloughed away, and became a discharging ulcer, half of the plantar surface being destroyed; that after six or seven weeks of treatment the foot showed no signs of healing but that it would for a time partially heal and then break down again; that the left foot and part of the left ankle presented a diffuse process, which spared only the heel; that the uppermost portion of this process was characterized by dusky induration with no gross break in the continuity of the epidermis; that over the anterior half of the foot, especially on the plantar surface and the medial portion of the dorsum, there was a large area of ulceration; that the upper portion of the ulceration was not continuous, but was made of pin-point to quarter-dollar sized ulcers; that these ulcers were irregular in outline and were not very superficial; that the bases were covered with a mild seropurulent exudate; that on the plantar surface the ulceration was much deeper and that the entire anterior two-thirds of the foot was covered by one large ulcer; that the borders were very irregular and varied in conformation from that of a definitely punched-out border to a definitely shelving border; that the base was covered with a purulent discharge, which was somewhat foul; that on the plantar surface and over the first metatarsal phalangeal articulation was a widely gaping incision; that there was no definite capillary stasis in the surrounding skin; that there was considerable induration; that in the areas of unbroken skin surrounding the ulcers there was considerable vesiculation, which was both discrete and confluent; that the plain-

tiff suffered excruciating pain of a burning sensation continuously, except infrequent interruptions when the pain would subside for a time and would then recur; that there was no appreciable swelling of the injured member; no appearance of red streaks running from the ulcerated area; that the plaintiff had a normal temperature and felt no fever or sickness except the pain and suffering described—with these facts in mind, Doctor, and assuming the description of the exposure in the preceding question, you may state what, in your opinion, caused the condition on plaintiff's left foot.

A. I think the description which was just given would apply to an irritation from an x-ray exposure.

Cross Examination by Mr. F.

Q. Would the description just given by Mr. S. apply to any other disease than an ulcer from an x-ray burn?

A. I think some forms of chronic inflammation might simulate that.

Q. What do you mean by idiosyncrasy and its application in x-ray?

A. Idiosyncrasy is recognized in science and as we usually understand applies to some people who are more sensitive to the exposure of x-ray, as some people are more sensitive to the action of the sun. A physician may follow out the established formula adopted by the profession for the x-ray and use all the proper factors calculated to be safe and proper and yet x-ray burns do occur, because of idiosyncrasy.

Q. Then it is a fact that a physician using ordinary care and skill and employing the proper factors in x-ray as described, may nevertheless burn the patient?

A. Yes, sir.

Q. Dr. Hickey, can a patient look at the tube, a layman, who is not accustomed to the x-ray room, looking at the tube and tell whether or not the x-rays are being emitted therefrom?

A. Not with a Coolidge tube, because the x-rays are invisible to the unaided eye.

Q. I will ask you if a patient is placed in a reclining position and a Coolidge tube is placed about fourteen inches in front of his foot between the knees and the foot fourteen inches from the tube, the bottom of the foot up and a hand fluoroscope is held at the bottom of his foot, can the patient looking down in a vertical position and direction see the shadow that would be caused by a foreign object in the foot? Can he see that shadow on the fluoroscopic screen?

A. If I understand your question correctly I think not, because he would be looking at the back of the fluoroscopic screen.

Q. Assuming that the patient is in a reclining position and the x-ray tube is placed in this position [illustrating tube pointing away from patient]?

A. Yes.

Q. Fourteen inches away from the bottom of his foot, then with the aid of the hand fluoroscope and the tube in this position, could the patient back here [illustrating] see the object, the shadow of the object?

A. I do not think so.

Q. Is it not a fact regarding the cumulative effect of x-rays, that 50 per cent of the rays' effect disappear in three days after the exposure?

A. We figure that 50 per cent of it is lost toward the end of the first week.

Q. Isn't it a fact that perhaps 94 per cent of it is entirely gone at the end of 17 days?

A. The average patient, yes, I would say so.

Q. Suppose, Dr. Hickey, that a patient is subjected to the x-ray at a target distance of ten or twelve inches and assuming a spark gap of 4 inches and of 5 milliamperes and that the exposure is continuous for two hours, when would you expect the primary erythema to develop, if one developed?

A. We would expect it to develop some time within the first 24 hours.

Mr. G. That is with a two-hour exposure?

Mr. F. Yes, two-hour exposure.

Q. Dr. Hickey, if a Coolidge tube, using a milliamperage of 4 and a spark gap of 4

inches, is in continuous operation for three hours, will you state whether or not the tube would be functioning at the end of three hours?

A. I think not.

Q. Using the factors of 4 milliamperes and 4-inch spark gap with the rays passing from the top to the bottom, if a burn occurred, where would you expect to find that burn? On the top or the bottom of the foot?

A. The tube at the top of the foot?

Q. Yes.

A. We would expect the burn to show its greater effect on the top of the foot. If it was exposed only on top, we would expect the greatest brunt of the exposure to appear on the side of the foot toward the tube. We would expect the burn to show its greater effect on the top of the foot.

Q. The question was asked, could you give a 20-minute exposure with 4 milliamperes and 4-inch spark gap for 20 minutes—would it be any different from an exposure over a period of 20 minutes that was intermittent and in which the fluoroscope was used and taken off?

A. Yes, it would be less severe according to the number of minutes you subtract from the actual exposure.

Re-direct Examination by Mr. G.

Q. If the exposure was greater on the bottom of the foot, the fact it being equal; we would expect the greater evidence of the burn to be on the bottom of the foot?

A. No. The bottom of the foot stands much more x-rays than the top.

Q. Supposing that the fluoroscope was placed on the shin or on the leg, the tube was placed back here and the rays penetrating through the bottom of the foot of sufficient strength to give a good picture, could the person, if he were conscious and alive, look through that side of the fluoroscope and see the picture?

A. The person whose foot was being examined could not.

Q. How many degrees of an x-ray burn are there?

A. I think we usually classify them in three classes: first, slight redness, which persists for a comparatively short time, which might be compared to the irritation of a sunburn; second, the type of burn where there is the production of blisters, similar to what one gets from a hot water burn; third, a deep burn, where the tissues lose their vitality and remain in an unhealthy condition for a considerable length of time.

Q. What is the best treatment for an x-ray burn?

A. Well, that depends, of course, a great deal upon the severity. If it is very resistant, usually the getting rid of the tissues which do not heal and then covering with a skin graft.

Q. Would a skin graft on the foot in the conditions of the foot I have described and indicated as being present in this case, be efficient?

A. According to the description you have given, I should think possibly not.

Q. Why not?

A. Well, the essential feature of an x-ray burn is the fact that blood vessels are damaged—the small blood vessels—so that the action of the individual blood vessels is decreased—a decreased amount of blood to the parts. If you have decreased action—no blood to the part—you don't have the conditions then which are favorable for the making of a skin graft.

Q. A skin graft would be more difficult on a large area than on a small area?

A. Yes.

Q. Is there any cure for an x-ray burn of the degree you have described as a third degree?

A. Well, if the blood vessels have been permanently damaged so there is an interference in amount of blood and proper amount of nourishment, I don't think there is, without cutting down to the healthy tissues.

Q. Dr. Hickey, Mr. F. asked you whether or not, if the rays, the current, was kept on for three hours would be efficient, you answered that it wouldn't because it would get so hot it would lose its efficiency, and I asked if, in the event of intervals the

tube was turned off for two to five minutes at a time, it would cool?

A. Yes, it would cool if it was off for five minutes, I think.

Q. How would you compute the total exposure for half a day, with the tube intermittently lighted and off?

A. In computing the total exposure for half a day or any other period, we would deduct the number of minutes which the tube was not on and consider the dosage to be the sum of the minutes it was on.

Q. So, regardless of the intervals, if the tube was on, actually penetrating the foot for a period of time and then at rest for an hour and another exposure for a certain length of time, you would add the two exposures together to determine the effect of the x-rays on the member?

A. Yes, if the séance or sitting occupied a total time of less than half a day. Considering the total exposure within half a day would not make much difference.

Re-cross Examination

Q. Have you ever produced an x-ray burn in a diagnostic procedure?

A. In our department, we have had evidence of an irritation in diagnostic work on a patient under my observation. We had one case of a Filipino who had had a series of dental x-rays made, the exposure which was over each area was ten seconds and that was followed by a very distinct tanning of the skin, which subsided. When the Coolidge tube first came out, I had a burn of the second degree, which lasted about two weeks. The Coolidge tube was pretty new in those days. I was very much surprised that I would get a burn.

Q. Assuming, Doctor, that a physician had used the following factors—4 milliamperes, 4-inch spark gap, 14-inch distance for a period of $5^1/_2$ minutes, would you say whether or not that would conform to the usual and ordinary practice?

A. Yes, that conformed with the limit of safety.

Q. A doctor, therefore, using these factors for that length of time would be using the ordinary care and skill?

A. Yes, sir.

Q. Suppose a patient were exposed on the 4th of September and the pictures were taken and a little fluoroscopic work was done, and then on the 18th of September, 14 days later, the foot showing no erythema, no tanning, would he be justified in subjecting the patient to further radiation if he deemed it necessary?

A. Yes.

Q. If on this second exposure on September 18th, the foot showing no reaction, the assistant would hold the patient's foot under the fluoroscope for the duration of the operation, his fingers being within the exposure to the x-rays and his fingers would not be at all burned and the reaction occurred on the foot, what would be your opinion as to whether or not the foot received an x-ray burn?

A. Well, if the hands of the assistant were equally in the field in which the foot was, we would expect the hands to show evidence of irritation if the foot did.

Q. The hand would be burned as quick as the foot?

A. If it received the same amount of rays, yes.

Witness was excused.

The incongruities and repeated contradictions in the hypothetical questions are so evident at this time (and were at the time of the trial) that any one can readily see that they were trying to pull the wool over good old "Pop's" eyes. He was far from well at the time, and even then agreed with what the holdings of the defendant claimed.

I was put on the stand for the defendant, and, after being qualified, testified as follows:[2]

Q. Are you acquainted with the practice of medicine and the use of the x-rays in the removal of foreign bodies in localities such as this and adjoining cities?

A. I am.

Q. Is it customary and the ordinary practice in cities of this size to use the

[2] Not because of its importance, but in order to place the evidence clearly before the reader, my testimony is quoted verbatim from the transcript.

fluoroscope to locate foreign bodies in a patient's foot?

A. It is.

Q. During such fluoroscopic examinations, are the x-rays filtered?

A. Usually they are not filtered or only lightly, slightly filtered.

Q. Suppose, Doctor, that, using the following factors, 4 milliamperes of current, 4-inch spark gap, at a distance of 14 inches for a period of 6 minutes, you may state whether or not that would be the customary and ordinary practice.

A. I would say that that would be the customary and ordinary practice and safe if used once.

Q. Would it be more or less than the ordinary practice and would it produce a burn on an ordinary individual?

A. It would be giving or applying less than what is the ordinary practice, decidedly less. That amount of x-rays would not produce what you are pleased to call a burn, but what we prefer to call a dermatitis, on the skin of an ordinary individual.

Q. Doctor, what do you mean by idiosyncrasy to x-rays?

A. Certain people are hypersensitive to the x-rays, just as some people are more sensitive than others are to the sunlight, the rays of the sun. Some people tan while others burn when exposed to the direct rays of the sun. That unusual tendency to burn is what we call idiosyncrasy in this particular situation. It is one form of idiosyncrasy. We have other forms of idiosyncrasies like those in regard to foods, drugs, and other things.

Q. Is there any way by which you may determine beforehand if a person has this idiosyncrasy to the x-rays?

A. No, there is no known way to determine the presence of idiosyncrasy to x-rays or any other agent, before or in advance of a test.

Q. Would you expect a reaction or burn with the use of the x-rays if the factors just given you were used? If not, how would you explain the occurrence of a reaction? Discuss it in your own way so that we may learn about it.

A. With the exposure for which you stated the factors, I do not see how a reaction in the nature of a dermatitis could occur, except in the presence of the most extreme and violent idiosyncrasy. If such a thing did occur, it would be due to idiosyncrasy, which is the unusual effect of the x-rays (in this instance) upon an individual who is particularly susceptible to these rays.

Q. Doctor, if the hand of one individual and the foot of another were exposed to the same factors and under the same conditions, and at the same time, which, if either, would be burned first or most?

A. If it was the back of the hand and the top or dorsal surface of the foot, the effect, if both persons were normal, would be the same. It would be identical if they both had equal sensitivity to the x-rays. On the other hand, if the back of the hand and the sole or plantar surface of the foot were exposed under the conditions you described, the sole of the foot would be far less likely to be affected, because the sole or plantar surface of the foot will tolerate about three or four times the amount of x-rays—in an ordinary individual—than will the back of the hands or the top or dorsal surface of the foot. If now, the foot showed evidence of irritation or dermatitis, under the conditions you stated, I would unqualifiedly say that the owner of the foot had a definite hypersensitivity or idiosyncrasy.

Q. If a patient is placed in a reclining position on a table such as this one and the foot is held in front of the x-ray tube and the doctor is at the plantar surface of the foot and the factors are 4 milliamperes of current, 4-inch spark gap, 14-inch distance and the doctor studies the condition of the foot by the use of a hand fluoroscope, you may state whether or not the patient on the table could see the object, the foreign body in the foot or the shadow of a foreign body present in the foot.

A. The man on the table—the patient—certainly could not see the object in the foot.

Q. Why?

A. Because the fluoroscope would be between the foot and the doctor who was using it, and the x-ray tube would be between the patient and his own foot. The image of the foot, in order to be seen upon the fluoroscopic screen in the hand fluoroscope, must be between the x-ray tube and the eyes of the examiner, and unless these relations prevail and are present, the foot or the foreign body cannot be seen on the screen in the fluoroscope. Furthermore, with the hand fluoroscope, such as that one on the table, no one except the person using it can see the shadow in the fluoroscope. If you will hand me that fluoroscope, I will demonstrate more clearly what I mean.

Mr. G. I think that is admitted. The defendant admits that.

Mr. F. For the purpose of information for the jury, I would like the witness to show it.

Mr. G. We admit he couldn't see it.

Mr. F. But he testified that he did see it.

Witness. The image of the object between the x-ray tube and this fluoroscope is seen on the fluorescent screen on the inside of this funnel-shaped instrument. In order to see that image or shadow of the object the eyes of the observer must be in the dark. That is why the small end is fitted with black fur, to shut out extraneous light. If now, the x-ray tube was energized, I held my hand against the large end of this funnel and held the fluoroscope to my eyes [indicating], I could see the shadow of my hand, particularly the bones of my hand on the fluoroscopic screen inside of the large end of this funnel-shaped box which we call a hand fluoroscope; but no other living person could see the shadow of my hand or the bones in it, no matter where or in what situation or position he stood or laid. Do I make it clear?

Q. Can anybody look at a Coolidge tube and determine if x-rays are being emitted from it?

A. Not from the side.

Q. The x-rays are invisible?

A. They are invisible.

Q. The fact that the filament is lighted indicates nothing if the x-rays are not burning?

A. The fact that the filament is lighted indicates that the x-rays can be produced if the high tension current is turned on to the tube. If the filament is not lighted, no x-rays can be produced in the tube.

Q. Dr. Trostler, how are x-rays produced?

A. The production of the x-rays is a complex process, not readily understandable except by those trained especially in that branch of physics. I will do my best to make it clear. The Coolidge tube is a special form of vacuum tube, of which that one on the table is an example. In order to produce x-rays two different electrical currents must be passed through it at the same time. A low voltage current—usually about 12 volts—enters the tube at the one end, the cathode end, and is passed through the filament. The filament is a coil of tungsten wire, which becomes hot because of the passage of the low tension current, just as does the filament in our ordinary incandescent lamps. Now, while the low voltage current is heating—lighting—the tungsten filament, a high tension current is passed through the tube and x-rays result. The passage of the low tension current is partly for the purpose of heating the bulb of the tube, or, rather, the vacuum of the tube, and the light from the filament acts as a track for the electric ions to pass from the heated cathode—the filament—toward the anode or other terminal inside of the tube, where the x-rays are produced by the impact—the striking against—of the ions or cathode stream on the anode of the tube. The anode or target of the tube is the heavy, solid structure in the middle of the bulb of the tube, from which the x-rays pass outward from a central point, toward the half of the tube, all passing in straight line away from the focal spot, which is the spot where the cathode stream is focussed.

Q. Now tell us, Doctor, what is meant by the spark gap of an exposure?

A. The spark gap or, as it is sometimes called, the equivalent spark gap, is a meas-

ure of the distance the electric spark will jump in air, at different voltages. When we talk about a 4-inch spark gap, we mean that distance between two moderately blunt points. A current that will exactly jump across a 4-inch spark gap at sea level and normal barometric pressure, is produced by a certain voltage of current. The voltage that will just jump across a 4-inch spark gap will not jump across a 5- or a 6-inch spark gap. It requires a higher voltage to jump greater distances, and less voltages to jump shorter distances.

Q. Assuming, Dr. Trostler, that an x-ray exposure is made to a patient, in a reclining position from the dorsum of the foot, the x-rays passing from the dorsum of the foot toward the plantar surface. If a reaction occurred or a dermatitis occurred, state if the dorsum or the plantar surface would first be affected.

A. The top of the foot, the dorsal surface. The part of the foot that is nearest to the x-ray tube, certainly.

Q. Assuming that you would use the factors of 4 milliamperes, 4-inch spark gap, and 14-inch distance for a period of one hour and thirty minutes, would you expect a dermatitis?

A. I certainly would, a good one—or perhaps we better say a bad one.

Q. When would you expect the dermatitis from such an exposure to first evidence itself?

A. Anywhere from 24 to 96 hours, probably within 48 hours. A delayed reaction might occur a little later, but almost certainly within 48 hours.

Q. Is an x-ray burn produced by heat?

A. No, it is not.

Q. Is it a chemical burn?

A. Chemical in the sense that light is a chemical, only.

Q. Explain as you understand an x-ray burn, that is, what way the x-rays produce the burn.

A. That is rather difficult to do, in lay language. Let us liken the x-rays to that portion of the sunlight that produces a sunburn. The principal part of the burning rays of sunlight are the ultra-violet rays. All forms of light, either ultra-violet, infra-red, x-rays, or other light are vibrations of ether, waves of ether, and the only difference between the light or photochemical rays, the ultra-violet rays, the infra-red rays, and the x-rays is in the length of their waves. Now, the ultra-violet rays of the sunlight are identical with certain ultra-violet rays which may be produced artificially, by means of an electric arc or by other means. These produce sunburn if caused by the sun and ultra-violet burns if produced by the artificially produced ultra-violet light. The x-rays produce the same sort of burns, but without heat. This is because they are of themselves cold light or cold waves of the ether. Some of these so-called x-ray burns are almost exactly like a sunburn, while others, of the more severe type, produce much more destruction of the tissue than do the burning waves from sunlight or the artificially produced ultra-violet rays. Neither the so-called burn from the ultra-violet, the sunlight, or the x-rays are true burns. True burns are produced by heat, either dry or moist, but always heat. The skin injury caused by corrosives or escharotics are more nearly like the so-called burns that we have produced by light in its different forms.

Q. Could we determine whether or not an x-ray exposure was proper if we had only two factors given? Only time and screen-target distance?

A. It would be impossible to determine. Four factors are necessary.

Q. And unless you have at least three of the factors, you cannot determine the other?

A. If you give me three of the factors, I could determine the fourth factor to produce the effect I wanted, if that is what you mean.

Q. But if you had only time and distance of the object from the target given you, you could not determine the spark gap?

A. Absolutely not, any more than you could tell the price of wheat if you knew that lemons were selling at thirty cents a dozen.

Cross Examination

Q. Would it help you any to know that a good impression was produced on the fluoroscopic screen?

A. Yes.

Q. Now, Dr. Trostler, assuming that the x-rays were penetrating through the bottom of the foot for twice as long a time as through the top of the foot, and also after the rays penetrated through the dorsum and there was a burn, would you expect the burn to be both top and bottom, if the exposure was too great, assuming the strength of the current as Mr. F. has designated in his question?

A. The bottom of the foot will tolerate about three times as much x-rays as will the top of the foot. That is also true of the palm of the hand, as well as the sole of the foot, due to the peculiar form of the skin.

Q. You mean the outside, the epidermis?

A. I mean the palms of the hands and the soles of the feet. Both of these have epidermis; but the bottom of the feet and the inside of the hands receiving radiation from an x-ray tube will tolerate approximately three times what the backs of the hands and the top or dorsum of the feet. Now, if the top of the feet received a certain amount of radiation, within safe limits, the bottom or soles of those same feet will tolerate about three times as much radiation of the same quality, without injury, under the same circumstances and conditions.

Q. Assuming that there were exposures upon both top and bottom; that there was a 15-minute exposure continuous, that is, time minutes, and the distance of 14 inches with a 4-milliampere current and 4 inches spark gap, and exposure from the top was 15 minutes?

A. At what distance?

Q. A 14-inch distance, and the exposure from the bottom was 30 minutes, or say 50 minutes, with intervals of from two to five minutes and would that dosage produce a burn on the bottom of the foot as well as on the top?

A. Your interjection of intervals of from two to five minutes makes the question unanswerable by me.

Mr. G. We will strike that out. Say there were no intervals.

A. There would probably be a burn on the top and on the bottom of the foot, under those conditions.

Q. Under the conditions just described, could the patient see the foreign body in his foot?

A. If the x-rays were passing from the bottom of the foot toward the top of the foot, the fluoroscope being placed near the shin bone, with the room darkened, he might be able to see the bones of his foot, and if his eyes were good enough to see a fragment of a needle at that distance he might see it on the fluoroscopic screen, if that screen were not covered by some other material or object. If he had the fluoroscope to his eyes the distance from the foot to his eyes would cause enormous magnification of the shadows upon the screen, and he would probably be unable to recognize anything.

Q. Would you expect a 15-minute exposure at the distance given to produce an x-ray burn?

A. At the voltage, milliamperage, and distance just given, I would.

Q. An exposure of 32 milliampere-minutes will produce an erythema at 14 inches?

A. I am unable to answer until or unless you give me the third factor.

Q. What is that?

A. The spark gap or voltage.

Q. Four-inch spark gap, according to the evidence in this case—it will produce an erythema?

A. I say that it will not produce an erythema.

Q. On what authority?

A. My own. I am an authority. I am the authority to back it up.

Q. Do you know Dr. Hickey?

A. I do. I know Dr. Hickey and have a very high regard for him.

Q. You say that the bottom of the feet will stand more x-rays than the top?

A. The bottom or soles of the feet will tolerate more than thrice and in some in-

stances where the feet are heavily calloused, more than four times as much x-rays as will the dorsal surface or top of the feet.

Q. Would 60 milliampere-minutes, 4-inch spark gap at a distance of 14 inches unfiltered, be a safe dose to the top of the feet?

A. That amount of x-rays would be bordering on the danger line, and I would not administer that amount under ordinary circumstances.

Q. If you did give that much and there was no reaction in two weeks, would you repeat it? And when?

A. If there was no reaction in two weeks, at the end of fourteen days, it would be safe to repeat it. It would be safe to give another exposure. If there was reaction, I would not give another exposure until the reaction had subsided. If it was a first degree reaction, it would subside in a few days. If it was a second degree reaction, where blisters had formed, and peeling of the outer skin, it might take a couple of weeks for it to subside.

Q. What is the treatment for third degree x-ray burns?

A. The treatment we are using for third degree roentgen dermatites in Chicago is to completely excise the ulcer area as early as possible, cut out the burned area, and let it granulate a little while and then transplant skin to the granulating area.

Q. How many third degree burns have you seen on the plantar surface of the feet?

A. I never saw a third degree x-ray burn on the soles of the feet.

Q. Do you see many x-rays burns?

A. We see numerous burns.

Q. Have you ever attended any other medical school than the one you named when you were qualified?

A. I have. Several.

Q. Are the x-rays dangerous to handle?

A. In the hands of one familiar with the use of the x-rays they are not dangerous, but they are dangerous in the hands of persons not familiar with them, exactly as are many of the things which we as physicians handle daily. Morphine and strychnine are dangerous to handle, but we use and handle them constantly.

Re-direct Examination. (Questions omitted for brevity.)

No person should attempt to use the x-ray unless he understands it.

Under certain conditions we may attempt to get an erythema in the use of the x-rays in the treatment of disease.

Under the best conditions and the best circumstances, some persons receive x-ray burns because of an idiosyncrasy, and there is no way known that will prevent it.

I cannot conceive of an instance in which proper surgical treatment would not be the advisable thing to do in a resistant third degree burn.

Re-cross Examination. (Questions omitted for brevity.)

The last burn I saw was on the back of a woman, just above the hip bones, in the pelvic region.

Any part of the body is susceptible.

I have seen burns on the neck. I have seen burns on the face and on the abdomen.

After excising the burn, the grafting of skin is a recognized treatment. It is often done.

It is not so liable to break down again if skin is grafted on the burned area, as it would be unliable to heal.

Yes, quite a number of the pioneers have died because of their injuries. Some of these, like Wolfgang Fuchs, of Chicago, Dr. Myran Kassabian, of Philadelphia, and others, had skin grafted on their hands, and even after that, they had to have their hands amputated. One man had about twenty operations, and then had to go, at the end.

Yes, I speak with a great deal of feeling, because so many of these men who began the use of the x-rays at about the same time as I did, are gone, while I have practically no evidence of injury from the rays, simply because I was lucky enough to receive a slight acute burn early and from it, realized that we were handling

something that did things to us, if we were not careful.

Re-direct Examination. (Answers only, for brevity.)

To determine the three degrees of a burn—and the x-ray burn is likened to other burns for the purpose of classification we classify them into first, second, and third degree burns; but there is no sharp or definite demarcation between any two of the three degrees. First degree burns consist of an erythema or reddening of the skin, similar to a slight over-exposure to the sun, wherein the capillaries of the skin—the small blood vessels in the skin—become dilated and permit of a larger amount of blood to show through. These same small blood vessels are dilated and produce the red color in the skin when a bashful person blushes. The only great difference between a first degree burn of the milder type and a blush is that the blush disappears quickly while the first degree burn lasts from a few hours to a few days. This reddening stops short of blistering. A second degree burn is from the point of mere reddening to blistering or the formation of blebs, such as are sometimes seen in a severe sunburn. The sunburn never gets beyond the second degree. A third degree burn is a deeper burn and consists as a rule of destruction of the skin and injury to the underlying tissues. These burns, or, as we prefer to call them, dermatites, when they are produced by the x-rays, usually pass through the three stages or degrees if they finally become third degree dermatites; but the interval occupied by the first or second degrees may be so short that these are not observed. Sometimes the third degree burns do not appear until quite late, in what we call a delayed reaction; but they never appear as a third degree burn from the beginning. There is always itching, stinging, and redness first.

Dr. M. J. Hubeny was next put on the stand and testified substantially the same as the writer and at the close of the case, all concerned felt that in the spirit of simple justice, the jury would find for the defendant physician, without leaving their seats.

All of the x-ray and pathological testimony exonerated the defendant physician when his—the defendant's—figures were taken into consideration. The only really damaging testimony was based upon the surgeon's pre-operative diagnosis, which was later disproven by Dr. Warthin's microscopic report, and the testimony of Dr. C. C. Croy; but the jury, evidently because the plaintiff had lost his foot and leg, brought in a verdict for the plaintiff with damages in the amount of $15,000.

The verdict was so obviously a flagrant miscarriage of justice that a motion for a new trial was immediately made. This was denied, and the case was appealed to the Michigan Supreme Court, where the judgment of the lower court was "reversed and a new trial granted." Because this Supreme Court decision contains much that is important and instructive, it will be quoted entire.

"Before the Entire Bench"

"This action was brought to recover damages for alleged malpractice by a physician in the use of the x-ray.

"Plaintiff stepped on a needle and it broke off in his foot. Defendant treated him and, plaintiff claims, so burned his foot in a negligent use of x-rays as to cause him great pain and suffering and the ultimate loss of his left foot, by necessary amputation, about ten inches above the ankle. A jury awarded plaintiff $15,000 damages. Defendant reviews by writ of error.

"At the close of plaintiff's proofs, defendant moved for a verdict in his favor. The court denied the motion. The motion was in the nature of a demurrer to the evidence and, in reviewing the denial, we must accord the testimony cerity and give it probative value within the limits of every reasonable inference the jury could draw therefrom. We find no error in the denial of the motion. At the close of the proofs defendant again moved for a directed verdict. The motion was denied.

We think the evidence presented an issue of fact for the jury.

"At the trial long hypothetical questions were asked expert witnesses by plaintiff's attorney, and counsel for defendant allege error in overruling their objections thereto. It is insisted that the questions did not state scientific facts essential to be considered in giving an opinion. The experts seemed able to answer without the particular factors assserted and, we think, the assumed facts in the questions justified the rulings. A hypothetical question was asked one expert and he was requested to state whether or not, in his opinion, the exposure of plaintiff's foot to the x-ray in the manner indicated was proper or improper. The expert answered: 'I would say it is highly improper.'[3]

"The court overruled the following objection:

"'The question invades the province of the jury; that the question is too long and improper to be understood by this jury: that it assumes scientific facts which are not in evidence without which it is impossible to intelligently answer the question.'

"The standard of care, skill, and diligence required by an x-ray operator is not fixed by the *ipse dixit* of an expert but by the care, skill, and diligence ordinarily possessed and exercised by others in the same line of practice and work in similar localities. We pass the form of the question and the nature of the answer and hold that there was no reversible error, for the reason that the question was based on the testimony of the plaintiff relative to the period he was exposed to the x-ray and which, if true (and had to be accepted as true by the expert), stated an exposure for a period even the merest tyro would know was improper, and every witness, including defendant, said such a dosage would have been improper. Defendant denied any such dosage. It should be remembered that an expert witness, in answering a hypothetical question, must accept as true every asserted fact stated therein, but the jury cannot consider the answer of the expert unless they find that the evidence establishes the truth of all such asserted facts. If the hypothetical question goes beyond the evidence, it defeats itself and affords an excellent opportunity for argument before the jury to that effect. *In considering a challenged hypothetical question we can give no thought to the weight of the testimony for, if there is any competent testimony supporting the asserted facts, the question goes to the jury. Plaintiff's case rested upon the charge of negligence on the part of defendant in administering an excessive dosage and depended in the main upon his own testimony. The doctrine of* "res ipsa loquitur" *is not recognized in this State and, therefore, proof of the burn was no proof of defendant's negligence* [author's italics]. Plaintiff had the burden of showing that he suffered an x-ray burn, occasioned by an overdosage or exposure to his foot, and that such happened because defendant failed to exercise the reasonable and ordinary care, skill and diligence possessed by others in the same line of practice and work in similar localities.

"The evidence discloses that x-ray burns do occasionally occur in the ordinary course of exposures and in spite of the highest diligence and skill to prevent them; the reason being that persons of a certain type and temperament are susceptible to a burn, while persons of a different type and temperament, under the same circumstances, will not suffer a burn. It also appears that this idiosyncrasy cannot be determined before or during the time of exposure but is manifested only by subsequent developments. Plaintiff assumed the risk of a burn from a proper exposure to the x-ray and defendant incurred the liability to respond in damages if the burn was occasioned by his negligence.

"There exists for the guidance of the operator of an x-ray machine certain formulæ. Plaintiff claimed his foot was exposed to the x-rays for two hours and a half, except for short intermissions. The x-ray, in this instance, was not for treatment, but to locate the needle in plaintiff's foot and to

[3] This question *involved what the plaintiff had testified to, regarding matters which he could not know.*

assist in an operation for its removal. Defendant claimed the foot was exposed to the x-rays but a few seconds at a time and altogether above five minutes, and that, while the plaintiff was in his operating room about two hours and a half, he was performing an operation on the foot to remove the needle, and did not require and did not use the x-rays, except as above stated.

"It is strenuously insisted, in behalf of defendant, that plaintiff's testimony relative to the time his foot was exposed to the rays should not have carried that question to the jury, because it was a physical impossibility for the plaintiff to have knowledge of or on the subject. The credit to be given the testimony of plaintiff relative to the time his foot was exposed to the rays rested with the jury and we may not hold it of probative value.

Defendant moved for a new trial alleging, among other grounds, error by the trial judge in making the following statement in the presence of the jury during the argument of counsel for defendant:

"'Mr. Cady, that is gross error. You had no right to use such an argument to the jury, and if the jury render a verdict for the defendant in this case, I will set aside the verdict.'

"The court stenographer was not present and the motion, in this particular, was supported by the affidavit of Mr. L. M. F., one of defendant's attorneys. No counter-affidavit was filed. The trial judge denied the motion and filed written reasons but made no mention of this subject. Defendant excepted to the denial and has brought the question here by assignment of error. Such assignment of error, of course, accompanied notice of settlement of the bill of exceptions and was before the trial judge when he signed the bill. The motion for a new trial, the assignment of error, and the brief of counsel for defendant all challenged the attention of counsel for plaintiff to this matter, and counsel for plaintiff, in his brief, took the position that the defendant cannot urge the point because his counsel did not object to the remark of the court. We need but say that counsel was not required to make an objection. If the remarks were made by the judge, counsel was in no position to act in the capacity of a moderator and was not required to challenge the propriety thereof by objection. An exception, under the present practice, could be claimed. At the argument in this court, the serious character of the claimed error was indicated and later counsel for plaintiff brought the matter to the attention of the circuit judge, who then filed in the circuit court, a supplemental opinion or reasons for denying a new trial, and plaintiff, by motion, asks that the record be amended by inclusion thereof. The case was argued and submitted in this court Oct. 5, 1927, and then taken under consideration. The supplemental opinion in the circuit court was filed Oct. 22, 1927, eleven months after denial of a new trial. In the supplemental opinion the circuit judge states that:

"'As I recall the situation, the affidavit of Mr. F. is not in strict accord with the facts. Mr. C. in his argument to the jury did use substantially the language as set forth in the affidavit of Mr. F. At that time the stenographer was not in the court room, and no record was being taken of the argument. As soon as Mr. C. had made the statement in question, Mr. G. attorney for the plaintiff, objected to the statement. The court thereupon told Mr. C. that in his judgment the argument was error and prejudicial, and that, should the defendant obtain a verdict from the jury, the court might be called upon to set the same aside because of such prejudicial argument.

"'When the court stenographer was called he took the following:

"'*Mr. G.* Counsel for the plaintiff strenuously objects to the statement of counsel for the defendant that the witnesses from Ann Arbor in this case were brought to this court by reason of influence of relatives of either the plaintiff's counsel or relatives.

"'*Mr. C.* I did not so state to the jury that I believed it was influence brought by the plaintiff's counsel or relatives.

"'*The Court* Counsel for the defendant

in arguing this case made the statement from which it might be inferred that he wants the jury to infer that *certain witnesses were induced to come here by relatives of someone connected with the plaintiff's case* [author's italics]. The court holds that this is highly prejudicial to the plaintiff and the jury are instructed to pay no attention whatever to the argument made by counsel in respect to this phase of the case.

"'*Mr. C.* I want also to have the record show that on being reprimanded by the court, I ask the court's pardon and ask the court to charge the jury to pay no attention to the remark—that this remark was brought out by the question by plaintiff's counsel yesterday asking the jury to determine what influence it was that brought these witnesses from Chicago to testify in the case and counsel for the defendant, if he is in error in making the remark, as said by the court, asks the jury to pay no attention to the remark whatever.' Is that satisfactory, your honor?

"*The Court.* Proceed.

"We must decline to supplement the record by inclusion of the opinion of the circuit judge rendered after the case was argued and submitted here and without our consent (O'Flyn *vs.* Eagle, 8 Mich., 135. See also Varrick *vs.* Hitt, 65 N. J. Eq., 778), and at this late stage we must decline to remand the bill of exceptions for inclusion of action after the certification of the record to this court. A bill of exceptions may be remanded for correction in accordance with facts existing at the time it was settled (People *vs.* Vanderhoof, 234 Mich., 419). But we may not remand a bill of exceptions, or the record, to have added thereto action taken in the circuit court to meet an error assigned and argued here and under advisement. The rule we state may appear a hard one in this instance, but there must be a rule on the subject, otherwise error may be plainly apparent on a record before us in a case argued and submitted and may then be met by subsequent action in the circuit court to cover the point.

"We adopt the rule stated in Johnson *vs.* Couillard, 4 Allen (Mass.), 446: 'Taking this bill of exceptions as allowed by the presiding justice, there is no error so palpable that it has been deemed proper to sustain the exceptions and set aside the verdict on that account alone. . . . . It is said by the counsel for the plaintiff, and we have much reason to suppose, correctly, that there is an error in the bill of exceptions, and that proper instructions were given on that point. But no amendment of the bill of exceptions having been offered until after the case had been submitted to us on argument by the representative counsel, we have not thought it proper at so late a stage of the case to receive any certificate to that effect without the consent of both parties, and especially in a case where the error can produce no greater evil than a new trial.'

"It seems the circuit judge in denying the motion for a new trial, did not notice this point and the briefs filed with him did not mention it and, therefore, he overlooked it in giving his reasons. We surely would not, before or after argument here, remand the record to enable the circuit judge to render a supplemental opinion or give reasons to meet an error assigned and much less should we countenance such action without our permission.

"Upon the record before us *we must accept the showing made in the affidavit of Mr. Ford and may not consider the traverse thereof in the supplemental opinion by the circuit judge* [author's italics].

"Upon the record before us a new trial should have been granted. The judgment is reversed and a new trial granted with costs to the defendant."

The case was set for the second trial about a year later, and I was notified to hold myself in readiness for it. In correspondence with one of defendant's attorneys, I wrote ". . . I am going to make bold to tell you a few things about this case as I see them and if you find that you want to use them, I will be glad to discuss them with you more at length.

"First, the reaction produced by over-

dosage of x-rays would not be and under any circumstances could not produce ulceration on the plantar surface of the foot, if the overdosage was applied to the dorsum of the foot. I tried to bring this out as well as I could at the time of the previous trial; but I think that further and more detailed questioning, along with the opportunity to show by diagrams with pencil and paper, will put this over to a jury in a clearer and much better way.

"Next, the report of Dr. Warthin *is the best thing you have if you can bring it out. It absolutely fixes the reason why they amputated the leg. The man had a dry gangrene, the treatment for which is amputation. THAT IS THE ONLY TREATMENT FOR DRY GANGRENE.* They operated for dry gangrene produced by and directly due to arteriosclerosis of the Monckeberg type.

"This 'marked Monckeberg calcification of arteries'—quoting Dr. Warthin's report of the pathological diagnosis—is a combination of fatty degeneration and calcification of the middle layers of the walls of the arteries. It usually occurs in the aged; but *it is not rare* in the arteries of the feet, legs, and thighs in men over 40 years of age. It is the so-called 'pipestem' or 'corduroy' artery, and is the type seen in practically all cases of dry gangrene, and is known not to be the result of x-rays.

"Further, from another aspect, the report of the pathological diagnosis says 'area of dry gangrene,' and *dry gangrene never is nor can it be a part of or the result of recent overdosage from x-rays.* I can get any number of competent experts to so testify.

"Still further, the last sentence in Dr. Warthin's pathological report stating that 'no active process,' shows that whatever pathology was present was of long standing, whereas any effect of overdosage of x-rays administered within the time shown by Dr. D.'s records, and those of the case *would be active.*"

Upon request for items to be brought out by the expert roentgenologist's testimony, I prepared the following:

"Burn could not result from the amount of x-rays used, according to the records of the defendant. Neither could it result from that amount of x-rays plus the action of ichthyol or such other solutions or materials used in the dressing of the foot after Dr. D.'s operation.

"*Note:* It may be well to steer clear of this; but if plaintiff's attorney brings out anything regarding dressing materials, I am prepared to testify that that combination would *not* produce a dermatitis, and my associate here will do likewise.

"*Burns* will not result from four times the amount of x-rays the defendant said he used—if the *wall* of the tube was 14 inches away from the skin and target or anode consequently 17 inches from the skin, as the tube used is $7^1/_4$ inches in diameter and the focal spot of the tube is in the center.

"Under the conditions testified to by the defendant, a slight erythema—similar to a sunburn and no more severe—*might* result *on the top* or dorsum of the foot (the part nearest the tube) if four times the amount defendant claims to have used, was applied. However, it may be well to keep clear of this unless it is brought out by the other side.

"*Burns* could not be produced on the plantar surface of the foot (the sole) when the x-rays were applied to the dorsum of the foot only. *This is most important.*

"*No x-rays* are being produced in the Coolidge x-ray tube when the filament or hot cathode is lighted. In other words, the filament or hot cathode of the Coolidge x-ray tube does not of itself produce x-rays. A high tension current *must also be passed through the tube at the same time. This is most important.* If you want this brought out, ask us to explain it, at the same time handing witness the tube.

"*The Coolidge x-ray tube* looks exactly the same to a lay person, whether there are x-rays being produced or not, *while the filament is lighted.* The x-rays are invisible to the naked eye. Some substance that will fluoresce must be used to determine whether any x-rays are being sent out by the tube. The eyes of the observer must

be in the dark in order for the fluorescence to be visible.

"*There is absolutely no sensation or effect upon any of the five senses from the x-rays:* there is nothing to be felt, seen (with the unaided eye), tasted, heard, or smelled. The apparatus used by Dr. D., which produces these mysterious rays makes a humming noise and these rays cause certain substances to act peculiarly; but it is the effect of the rays and *not* the rays themselves that we see. The x-ray-producing apparatus makes as much noise while it is running and not producing x-rays as it does when the x-rays are being put out by it.

"*Lying.*—The plaintiff deliberately *lied* when he said that he could see the needle in his foot. He may have seen the light from the filament of the tube, but even that was pointed away from him. If you want to bring that out, ask for an explanation of how and why the Doctor could see and why plaintiff could not see it."

The case was tried again, but Dr. Hickey, Dr. Warthin, or the surgeon who amputated the leg did not testify at the second trial. Dr. A. W. Crane, Dr. M. J. Hubeny, and the writer were called as experts by the defense, all agreeing materially with my testimony in the first trial.

The jury, evidently out of sympathy and compassion, which was very strongly played up by plaintiff's attorneys in this second trial, brought in a verdict for the plaintiff, and the case was finally settled.

Here was a case in which the injury, alleged to have been caused by the x-rays, occurred on the plantar surface of the foot, when all the radiation occurred on the dorsal surface of the foot; in which roentgenograms of the amputated member as well as of the other foot and leg showed arteriosclerosis ample to produce the dry gangrene that the pathologists found in the amputated member, yet with all that well presented to twelve men sitting as a jury, the physician who was trying to do his best to relieve plaintiff was found guilty of malpractice and had to pay.

This case is one example of why we as radiologists have to pay such high rates for our malpractice insurance.

(*To be continued*)

OSTEOPOIKILOSIS[1]

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OSTEOPOIKILOSIS is a comparatively rare disorder which is generally conceded to be an anomaly of the skeletal structure that, because it is usually asymptomatic, is discovered most frequently by accident in the course of roentgenographic examination for evidence of, or for the cause of, other lesions. Albers-Schönberg first described osteopoikilosis in 1915.

A man, 21 years of age, came to him for examination because of various pains in one of his shoulders and one of his feet. He had acquired the condition during several months of trying service in the trenches. In civil life he had been an "enamel-burner" and, except for the symptoms just mentioned, he was in good health. Roentgenographic examination elicited, in all parts of the skeleton but the skull, clavicles, scapulæ, spinal column, and patellæ, and almost exclusively in the spongy substance, a peculiar structure consisting of round or oblong, but generally rather closely clustered dense spots that gave the bone a characteristic speckled appearance. These spots varied in size from 2 to 5 cm. in length, and the higher they were situated in the metaphyses the larger and longer they were. They appeared even in the corticalis, but without elevation of the surface. In the small bones of the hands and feet, and especially in the heads of the metacarpal bones, the shape was chiefly round. All the spots were clearly defined. A few of them were not quite compact but, as was the case in a phalanx of the thumb, were ring-shaped, with a lighter center. The longitudinal axis of the spots invariably agreed with the longitudinal axis of the skeletal parts in question, and in the short bones the structures of the bone shafts were generally followed with fair distinctness.

Ledoux-Lebard, Chabaneix, and Dessane reported a similar case in 1916, and because of the spotted appearance of the bones they gave it the name "osteopoecilia."

Some thirty-two cases have been reported in the literature, and in these involvement has been noted in the clavicle, scapula, patella, and spinal column; the spottings were less numerous, however, in these bony parts, and they have been in the accessory processes of the vertebræ and not in the bodies. Mascherpa stated that Bistolfi, in 1927, presented the case of a person 21 years of age in which nodules were found in the occipital bone. Other than this no lesions have been reported involving the skull.

In August, 1934, an American-born Jew, aged 26 years, came to the Clinic with an indeterminate abdominal lesion and an excessive flatulence which had been present for ten years. This flatulence had been aggravated following an abdominal operation elsewhere four months previously. During routine examination, the patient mentioned that roentgenograms made elsewhere had exhibited some abnormality of the skeletal structure. The patient also stated that an only brother had a similar abnormality of the skeletal structure on similar examination elsewhere.[2]

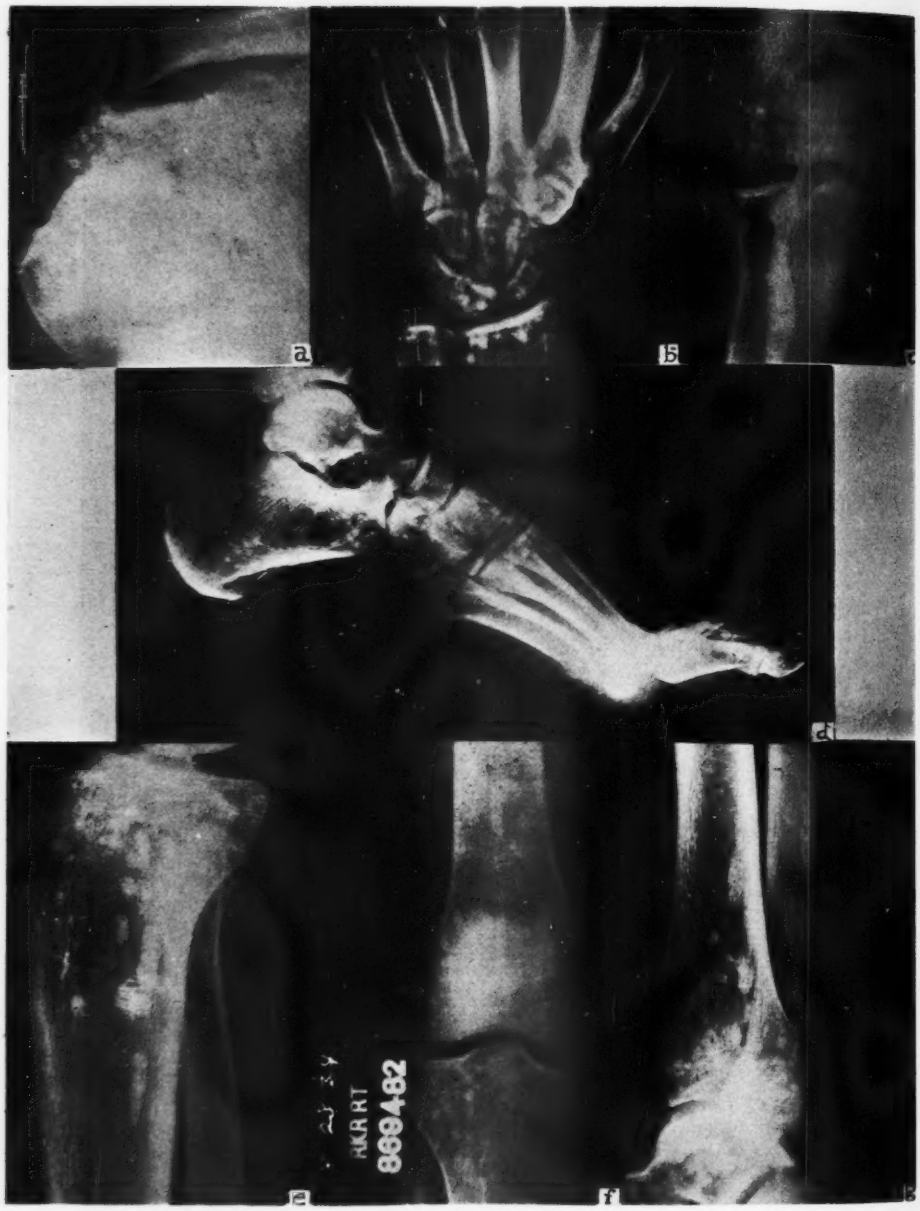
Roentgenographic examination at the clinic revealed diffuse mottling of the bone of the acetabulum, pubis, and ischium, with a few scattered spots running into the outer third of the ilium on both sides (Figs. 1-*A* and 1-*B*). This diffuse mottling also involved the neck and head of the femur on both sides and the shafts of the femur to about 5 cm. below the intertrochanteric line. General examination of the skeleton showed spotting of the bone in the epiphysis of the humerus, radius, and ulna,

[1] Read before the meeting of the Minnesota Radiological Society, Rochester, Minn., Oct. 13, 1934. Submitted for publication May 17, 1935.

[2] Since this was written word has been received from Dr. John W. Riley, of Tulsa, Oklahoma, that the mother of the patient showed bone changes similar to those exhibited in the brother.

Fig. 1-*A* (*above*). Osteopoikilosis involving the sacrum, the lower portions of the iliac, ischiatic, and pubic bones, and the head, neck, and shafts of both femurs.

Fig. 1-*B* (*below*). Osteopoikilosis showing discrete markings in bones of the hands. Compare these markings with the rather irregular "spotting" in the bones of the pelvis and in the femurs.



Figs. 2-*A*–2-*G*. Osteopoikilosis of epiphyses and extending to diaphyses. Note the discrete mottling of epiphyses and tendency to striation as lesion extends to diaphyses.

at both extremities, in all the carpal bones, and in the extremities of the metacarpal bones and phalanges. The acromion process of the scapula revealed similar spotting. The lower ends of the femurs were mottled with discrete rounded shadows in the epiphyses and linear shadows extending approximately 10 cm. into the diaphyses. The spotting was confined to the head of the fibula on both sides, but in the tibia a discrete mottling involved the epiphyses, and there were linear striations extending

about ten centimeters along the diaphyses. These striæ were broad, averaging 5 mm. in width. Similar involvement was noted in the lower portion of the tibia, and there were striæ extending into the diaphyses of both the tibiæ and fibulæ. The distribution of the discrete mottling seen in the bones of the feet was very similar to that in the hands, the spotting was largely limited to the epiphyseal portions of the metacarpals and the metatarsals, with only occasional involvement of the diaphyses; when this did occur it tended toward a linear striation. There was a discrete mottling throughout the bones in the carpus and tarsus (Figs. 2-*A* to 2-*G*). There was no definite evidence of involvement of the bodies of the lumbar vertebræ, but there were a few scattered spots in the spinous processes. The skull did not reveal any changes in bone.

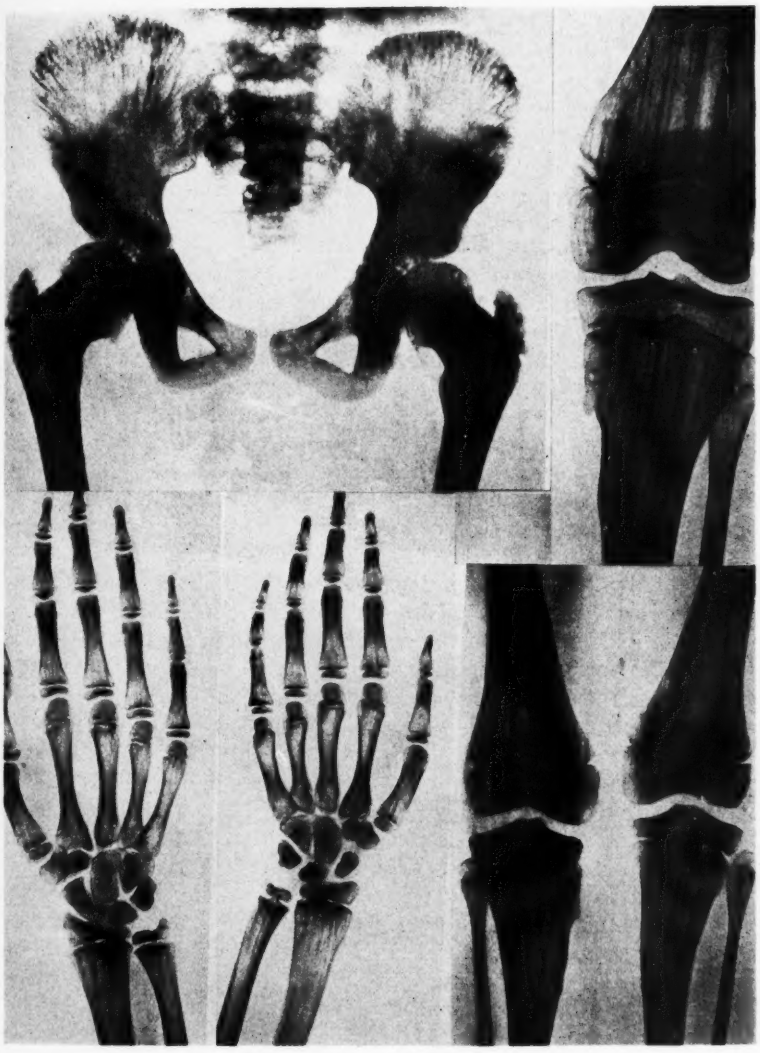


Fig. 3. Osteopoikilosis. Roentgenograms from case reported by Voorhoeve (Acta Radiologica, 1924, **3**, 407. *Reproduced by courtesy of that Journal.*)

Roentgenologic investigation of the thorax and gastro-intestinal tract did not reveal any abnormalities. Urinalysis, blood count, and morphologic examination of blood smears and serologic tests for syphilis all proved negative. The patient had no clinical symptoms referable to this condition of the bones other than a dull ache on cool days, usually in the legs. A large keloid had developed in the abdominal scar from the former operation. Hematologic determinations revealed calcium, phosphorus, phosphatase, and the albumin-globulin ratio to be within normal limits.

Voorhoeve, in 1924 (Fig. 3), found a strikingly different type of lesion in the case of a boy, aged 14 years, while making a roentgenographic examination to elicit the cause of a chronic synovitis in a knee joint. Dark, vertical, and very pronounced rays were revealed, giving shadows much stronger than those of normal bone. In portions of the femur, tibia, and fibula contiguous to the articulation, they ran almost parallel to the long axis of the bone; commencing at the epiphyseal line they were prolonged into the diaphyses, some of them for a distance of 8 cm., and similar rays were seen in the pelvic bones, wings of the sacrum, calcanei, scapulæ, and ribs near the costochondral articulations. The direction of the rays was found everywhere to be the same as that of the architecture of the spongiosa. The iliac bones, femoral neck, and calcanei clearly showed this arrangement. Roentgenographic examination showed that this boy's sister had the same skeletal affection, even greater in some areas than that of her brother. The father also gave evidence of alterations in structure which were similar to those of the children but to a much less degree. Nothing abnormal was found in the skeletal structure of the mother. Voorhoeve found clear spots where, sometimes, the ordinary structure of the bone was no longer visible (giving the impression of vacuoles), and small exostoses in very large numbers which were somewhat similar to those seen in multiple congenital exostoses. He also found points of osseous condensation in the phalanges of the hands and in the carpal bones. Re-examination of the children one year later did not show any changes of note. He suggested that chondrodysplasia (multiple congenital exostoses) and osteopoikilosis (osteitis condensans disseminata) might be two manifestations and phases of the same process.

Newcomet reported the first case of osteopoikilosis in the American literature, in 1929, under the name of "spotted bone." He had examined his patient after a four-year period and found no alteration in the character or extent of the lesion. Schmorl, in 1931, reported the first study of the condition at necropsy and stated that: "No deductions can be made from the microscopic findings concerning the genesis of this disease. An endochondral origin can be eliminated on the basis that the foci show no connection with the endochondral zone of growth. The most plausible theory is that of a congenital anlage."

The hereditary phase of osteopoikilosis is not discussed in the greater number of articles available for review, but, as before mentioned, Voorhoeve found evidences of involvement in the father and a sister of his patient. Awalischwili's patient was one of a peasant family of eight brothers and two sisters, and none apparently were found to be involved. The two patients whose cases were reported by Wilcox (23 and 24), in 1932 and 1933, were of one family, the son having more extensive involvement than the father. A sister had marked hypertrophy of the inner and outer tables of the skull, the two tables being completely fused. The process involved the skull on the right side, from near the vertex posteriorly to the level of the supra-orbital plates, the hypertrophy extending into the sphenoidal sinus. The mother thought the deformity, which had been known since the girl was five years of age, was a residual of injury from forceps delivery of the child. Sváb reported three cases occurring in one family, a father and two sons, and just as has been noted in other cases the lesions were less widely distributed in the father. The mother of these two sons and a small daughter of the younger son were examined

roentgenologically and found to be free from any abnormalities in the bone. In the case reported in the present paper, an only brother presented evidence of involvement of bone similar to that seen in the patient.

There have been many suggestions regarding the etiology of osteopoikilosis. Schinz, Baensch, and Friedl were of the opinion that it is a maldevelopment, and probably arises by a mutation and occurs recessively; they pointed out in a diagram the symmetrical distribution of the lesions. Sváb considered heredity important and thought that diabetes exerted an aggravating influence in his cases. He quoted Buschke and Ollendorf as having pointed out analogies between disseminated lenticular dermatofibrosis and osteopecilia. Wachtel suggested that the condensations corresponded in their situations to emboli of the terminal arteries. Tuberculosis has been considered to be only a coincident occurrence in some of the cases and not an etiologic factor. Greig has asserted that calcification is a passive process and occurs in feebly vascularized structures; the blood calcium is maintained within narrow limits of the normal, apparently by the action of the normal parathyroid glands, and any extra calcium is not met by the depletion of the blood calcium but by extraction from the great store of calcium available throughout the skeleton. Conversely, however, should the calcium content of the blood serum be high, it is conceivable that general calcinosis may result, and some dysfunction of the parathyroid glands may then be suspected. Calcification is not a primary manifestation and, when discovered, is evidence that the structure in which it occurs has undergone functional deterioration and is out of action, at least to some extent. His observation that if the blood supply to a bone is decreased the bone undergoes increased calcification, is in agreement with observations of Schinz, Baensch, and Friedl, and Wachtel as to the probable mechanism of deposition of calcium in this lesion. The definition of the etiology is probably a physicochemical problem.

The roentgenograms in the case reported by Nichols and Shiflett, by the unusual features which they presented, bring another type of unexplained developmental anomaly into the discussion. Léri and Joanny, in 1922, reported a lesion of bone of which they had been unable to find another example in the literature. Roentgenographically, certain aspects of all the long bones in one extremity revealed thickening and irregularity of the contour shadow due to a mass of compact, dense bone "smeared" over them in a manner suggesting a flow of some viscid material along one border of the bone. The involvement did not correspond to any peripheral nerve distribution, nor did it appear to have any relation to the vascular distribution. They gave this lesion the name "melorrheostosis," which they considered indicated the essential clinical characteristic hyperostoses, from "melos" meaning *a member* and "rhoea" *to flow* (Fig. 4). Lewin and MacLeod, in 1925, reported a similar lesion, and invited suggestions as to its nature (Fig. 5). The family history in this case was negative, no other members of the family having any defects of bone, although a grandfather had predicted that the patient would have trouble with the bones of his right forearm and hand until he reached the age of 30 years; this was the only suggestion of an hereditary factor. Junghaven found five cases described in the literature up to 1930; he had followed one case roentgenologically and clinically, and studied material obtained when osteotomy was done. He found a sclerotic or eburnating degeneration of the bone, and, because it had been in all reported cases monomeric (localized to one extremity), he suggested the name "monomeric eburnous osteosis." The osseous change begins in early age and, clinically, results in an increased volume of the limb, with secondary deforming arthritic changes due partly to hyperostotic developments along their cortical envelope, and partly to displacements resulting from these. He was inclined to consider it as an anomaly. Kahlstorf tabulated 10 cases, in 1930, which he had found in a review of all cases in the world literature. He stated

Fig. 4. Melorrheostosis. This was one of the earliest cases seen on this continent and was not published at that time because the condition had not been recognized. *Courtesy of W. G. Hermann, M.D., Asbury Park, N. J.*)

Fig. 5. Melorrheostosis. The roentgenograms were sent to various consultants some years ago and none had seen a similar lesion. The suggestions were that it was some type of neurotrophic disorder. (*Case reported by Lewin and MacLeod. Reproduced by courtesy of Journal of Bone and Joint Surgery.*)

that it had not been possible to determine the etiology and pathogenesis. The process apparently arises within the bone and has an extremely slow progress toward the surface, and only on involving the periosteum and joint surface does it give rise to subjective joint symptoms. He considered that this rare disease of bone was a disease *sui generis*, distinguishable from all other known diseases of bone, either generalized or localized, and attacking only bones of single extremities in segmented stripes. Progress is in a more or less straight line. He quoted Putti as regarding vascular changes as the primary cause, the vascular changes themselves being primary sclerosis with its origin in the sympathetic nerve. He pointed out, however, that the distribution of the process did not coincide with that of the sympathetic innervation. Policard, he stated, regarded narrowing of the vascular lumen as secondary. The discovery of further cases in which the distribution disagreed with the distribution of peripheral nerves led him to doubt Lewin and MacLeod's belief that the bone affection was related to a lesion of the peripheral nerve of the corresponding spinal ganglion. Léri and Lièvre's suggestion of a parasitic infection, from the striped arrangement and partial involvement, leading to continuing broadening and slow tendency to progression and generalization has not definitely been proved. Zimmer's assertion that a disturbance of development, in the lack of an anlage in a segment of the attacked extremity, would well explain the striped arrangement because only one segment is laid down defectively. The illustrations of Nichols and Shiflett present, along with the characteristic lesions of osteopoikilosis, involvement of the bone shafts which at first glance strongly suggests melorrheostosis. However, on referring to the illustration in which they have assembled the roentgenograms, one finds that the distribution involves both upper and lower extremities, and is, in a manner, bilaterally symmetrically distributed. Study of the individual extremities indicates a lack of continuity of the shadow along the bone observed in melorrheostosis, and examination of the individual bone shows bilateral increased density and thick-

ening of the cortical shadows, all of which would seem to rule out melorrheostosis as a coincident lesion. It is of interest that their patient clinically gave evidence of endocrine dysfunction.

A review of the subject of multiple cartilaginous exostoses (chondrodysplasia) on which some 400 articles have appeared in the literature, dealing with more than 700 cases, reveals that this lesion has been observed in different forms and described under various names according to the theories advanced as to its nature and etiology. It presents features in common with osteopoikilosis, to which it has been linked by the findings of Voorhoeve. It is hereditary and familial, and affects both males and females, the former more frequently than the latter. It apparently may be transmitted by an unaffected female. Both are evidently diseases of the period of skeletal growth, are first noted in infancy or in early childhood, increase with skeletal growth, and cease to develop about the time of skeletal maturity. The most probable hypothesis as to etiology is given as a disturbance in development of the intermediary cartilage due to an original defective anlage; the lack of an anlage in the involved extremity is the most generally accepted theory of the etiology of melorrheostosis.

Roentgenographically, chondrodysplasia appears to be an entirely different type of lesion from osteopoikilosis and melorrheostosis. In the last two the evidence suggests a diminution or cutting off of the blood supply, either primary or secondary, whereas in the first the evidence strongly supports the theory of Keith that a defect in the periosteum removes the restricting influence that it exerts in the proper shaping of the bone.

Chondrodysplasia and osteopoikilosis are hereditary and familial; there was only one suggestion that I could find of the hereditary factor in melorrheostosis. The cases reported by Voorhoeve and by Nichols and Shiflett are of particular interest, because the former lack entirely the spotting which gave the condition its name, and the latter present areas of typical spotting of osteopoikilosis and massive, irregular eburnation of the bone shafts distributed in a manner entirely different from that of the other reported cases of melorrheostosis.

With the extensive experimental investigation now under way to determine the part played by the endocrine glands in disorders of bone, we may have some additional information supplied that will assist in classifying more accurately these comparatively rare lesions. In the meantime it is imperative that all similar lesions be reported in order that such cases may be made available for study and comparison.

BIBLIOGRAPHY

(1) Albers-Schönberg: Eine seltene bisher nicht bekasnte Strukturanomalie des Skeletts, Marmorknochenkrankheit. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1915–1916, **23,** 174, 175.

(2) Awalischwili, G. G.: Zur Kasuistik der Osteopoikilie. Röntgenpraxis, Sept. 15, 1930, **2,** 831–835.

(3) Bistolfi: Quoted by Mascherpa.

(4) Buschke and Ollendorf: Quoted by Sváb.

(5) Greig, D. M.: Clinical Observations on the Surgical Pathology of Bone. Oliver & Boyd, Edinburgh, 1931, 248 pp.

(6) Junghaven, Sven: Monomeric Eburnous Osteosis. Acta Radiol, 1930, **11,** 121, 122.

(7) Kahlstorf, A.: Zur Kenntnis der Melorheostose (Léri) und der generalisierten Ostitis condensans oder Osteopoikilie (Albers-Schönberg). Röntgenpraxis, Aug. 15, 1930, **2,** 721–732.

(8) Keith, Arthur: The True Nature of the Condition Known as Multiple Exostosis. Trans. Med. Soc. London, 1920, **42,** 67–73.

(9) Ledoux-Lebard, Chabaneix, and Dessane: L'osteopoecilie, forme nouvelle d'ostéite condensante généralisée, sans symptômes cliniques. Jour. Radiol. et d'électrol., 1916–1917, **2,** 133, 134.

(10) Léri, André, and Joanny: Une affection non décrite des os: hyperostose "en oculée" sur toute la longueur d'un membre ou "melorheostose." Bull. et mém. Soc. méd. d. hôp. de Paris, July 21,1922, **46,** 1141–1145.

(11) Léri, André, and Lièvre, J. A.: La melorheostose (hyperostrose d'un membre "en coulée"). Press méd., June 27, 1928, **36,** 801–805.

(12) Lewin, Philip, and MacLeod, S. B.: Osteosclerosis, with Distribution Suggesting that of the Ulnar Nerve: An Unclassified Bone Condition. Jour. Bone and Joint Surg., Oct., 1925, **23,** 969–979.

(13) Mascherpa, Fermo: Sullo osteopecilia. Un nuovo caso di osteopecilia a strie. Radiol. med., August, 1931, **18,** 1014–1026.

(14) Newcomet, W. S.: "Spotted Bones." Am. Jour. Roentgenol. and Rad. Ther., Nov., 1929, **22,** 460–463.

(15) Nichols, B. H., and Shiflett, E. L.: Osteopoikilosis: Report of an Unusual Case. Am. Jour. Roentgenol. and Rad. Ther., July, 1934, **32,** 52–63.

(16) Policard: Quoted by Putti.

(17) Putti, V.: Una nuova sindrome osteopatica: L'osteosi eburneizzante monomelica. Chir. d. org. di movimento., June, 1927, **11,** 335–361.

(18) SCHINZ, H. R., BAENSCH, W., and FRIEDL, E.: Osteopoikilie. Georg Thieme, Leipzig, 1932, **1,** 289, 3d ed.

(19) SCHMORL, G.: Anatomische Befunde bei einem Falle von Osteopoikilie. Fortschr. a. d. Geb. d. Röntgenstrahlen, July, 1931, **44,** 1–8.

(20) SVÁB, VACLAV: A propos de l'ostéopoecilie héréditaire. Jour. radiol. et d'électrol., September, 1932, **16,** 405–415.

(21) VOORHOEVE, N.: L'image radiologique non encore décrite d'une anomalie du squelette. Acta Radiol., 1924, **3,** 407–427.

(22) WACHTEL, HEINRICH: Über einen Fall von Osteopathia condensans disseminata. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1919–1921, **27,** 624, 625.

(23) WILCOX, L. F.: Osteopoikilosis (Disseminated Condensing Osteopathy). Am. Jour. Roentgenol. and Rad. Ther., 1932, **27,** 580–584.

(24) IDEM.: Osteopoikilosis. Am. Jour. Roentgenol. and Rad. Ther., Nov., 1933, **30,** 615–617.

(25) ZIMMER, P.: Über einen Fall einer eigenartigen seltenen Knochenerkrankung, Osteopathia hyperostotica—Mélorhéostose. Beitr. klin. Chir., 1927, **140,** 75–85.

NEW TECHNIC FOR THE ROENTGEN EXAMINATION OF THE SHOULDER JOINT

By H. JORDAN, M.D., *New York City*

THE bones of the shoulder girdle are so superficial and anatomically so characteristic that their clinical examination is quite easy. It is, therefore, all the more surprising that they should cause difficulty in roentgen examination, conditioned mainly by the attachment of the shoulder girdle to the trunk, and by the relative position of the individual bones in an anteroposterior direction.

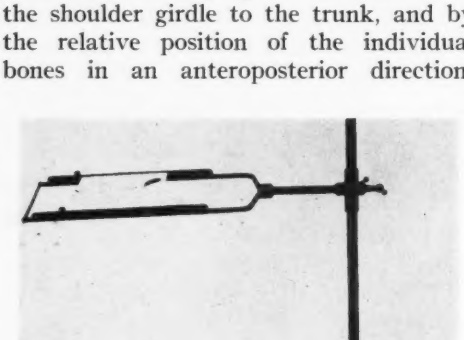


Fig. 1.

As a result, in the roentgenogram, part of the shoulder girdle will be nearer to, and part farther from, the film and nearer to the focal point of the tube. Furthermore, the barrel-shaped structure of the trunk with its individual variations interferes with the typical position of the patient, and may even render exact comparative exposures of both shoulders in the same patient difficult if not impossible.

The roentgenogram also gives a two-dimensional shadow of a three-dimensional body. Hence, the so-called projection plays a decisive and at times embarrassing part. Interpretation of the shadow is complicated by the fact that the projection is affected by the shifting of the x-ray beam, and by changes in the position of the object if the position of the film is considered fixed. Naturally, these changes are utilized in order to obtain more information in difficult cases.

"Deceptive projection" and other errors may be avoided by taking typical, standardized roentgenograms of the shoulder girdle in two planes at right-angles to each other. This may be done as easily and as readily as carrying out the routine in making x-ray exposures of the extremities and the spine.

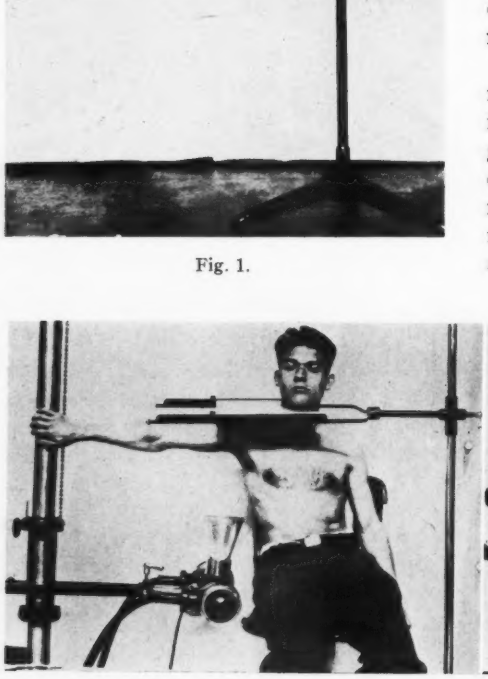


Fig. 2.

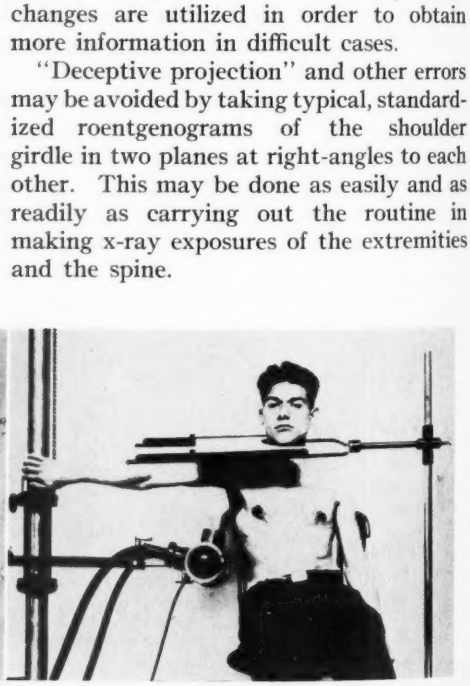


Fig. 3.

The present-day routine roentgenographic examination of the shoulder girdle is still limited to one exposure in the anteroposterior direction. The so-called "axial exposure" is employed only in isolated cases, and in my experience is not the standard one in many hospitals. As a rule, the examination of the shoulder girdle in two planes at right-angles to each other is dispensed with, and the diagnosis is based on one view only. Without exposures in two directions, the diagnosis of injuries and diseases of the shoulder joint, of the clavicle and the upper third of the humerus, would be as incomplete as that of the extremities and the vertebral column. It is in the shoulder girdle that numerous lesions occur which play an important part in surgery, but which may escape correct interpretation unless lateral films are taken. I need only mention the oblique longitudinal fractures of the acromion, fractures of the capital and subcapital end of the humerus, and the arthritic changes of the acromio-clavicular joint. Particularly fractures of the upper end of the humerus, with or without dislocation of the shoulder joint, require axial exposure, since by this technic alone can the true position of the fragments be judged. Technical difficulties in taking the axial view are undoubtedly the only reason why x-ray examination of the shoulder girdle in two planes has not yet been adopted as a routine.

The customary anteroposterior exposure of the shoulder joint may, of course, be most usefully supplemented by a posteroanterior exposure, though the applicability of the latter is so limited that it does not deserve being standardized as "typical second plane."

The same, in my opinion, is true of the stereoscopic view of this region. Like Boehler, I must emphasize the inadequacy of a stereoscopic exposure in a single plane. One must take either stereoscopic exposures in two planes at right-angles to each other, or stereoscopic views must be used only for supplementing the two-direction exposure.

Fig. 4.

For many years I have endeavored to elaborate an exact technic for the lateral or axial shoulder view. After several experiments, I finally have obtained satisfactory exposures by using a simple apparatus, which enables one to take standardized axial views in every shoulder case.

The exposure is made with the patient sitting on a stool, employing a shockproof tube, which, at about the height of the seat, can be approximated to the patient's body without danger (Fig. 1). The direction of the rays is vertically upward. The arm is abducted horizontally, whereby the patient's hand finds support on the upright of the tube stand. The position of the cassette is very important. The cassette is cut out at one end, so as to fit around the neck to bring the plate near enough to the mid-line of the body. For this purpose a cassette holder is required which is attached and moves easily on a light pedestal. This special cassette can be fixed at any desired point of the frame. A metal rim prevents the cassette from slipping and carries two movable screw clamps to press it against the patient.

Fig. 5.

Fig. 6.

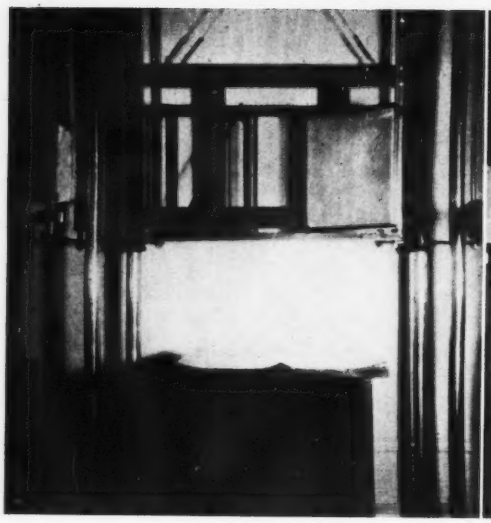


Fig. 7.

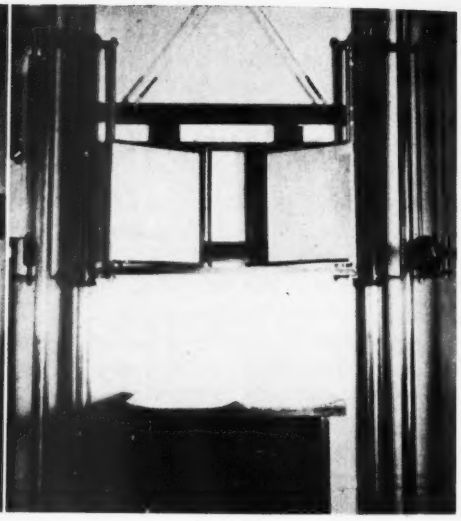


Fig. 8.

After seating the patient in the prescribed manner and centering the tube, the cassette holder is pushed over the patient's shoulder girdle from the unaffected side, and the special cassette is adjusted so as to lie just above the shoulder without being supported by it (Figs. 2 and 3). It is important that the cassette should not touch the shoulder, but should be carried solely by the holder. During exposure the patient is told to hold his breath. This fixation has proved quite sufficient with the average exposure of a few seconds. There is no blurring. The use of this exposure technic is only impossible if the arm is fixed to the trunk or if it cannot be abducted at least 75 degrees. In such a case the patient has to be placed in the lateral sitting position, and a picture is obtained by aiming frontally through the thorax (Fig. 4). In recent injuries I always think it advisable to use local anesthesia before the roentgen examination, and to reduce the fracture, etc., immediately afterward. This method is to be specially recommended for fractures of the head, of the humerus, and of the acromial end of the clavicle.

The method described makes radiographs of the shoulder joint in two planes so easy that there is no objection to using this technic as a routine (Figs. 5 and 6).

Owing to the anatomic peculiarities mentioned at the beginning of the paper, it is somewhat difficult to take compara-

tive pictures of both shoulder joints under exactly the same radiographical conditions.

The barrel-shaped structure of the trunk and the attachment of the shoulder girdle to it make it practically impossible to obtain strictly comparable films of both shoulders with the patient lying on his back. In the prone position, the shoulder joint is far away from the table, and, therefore, we tilt the patient, as a rule, on the respective side, in order to bring the joint proper as near to the film as possible and to avoid distortion. However, even by tilting the patient on his side, one frequently has to bring the film closer to the patient by means of sand bags, etc., features which are extremely difficult to measure or judge, and which, therefore, cannot be reproduced for the comparative x-ray with constant exactness. This is all the more true if we are dealing with a marked kyphosis or even a very obese patient.

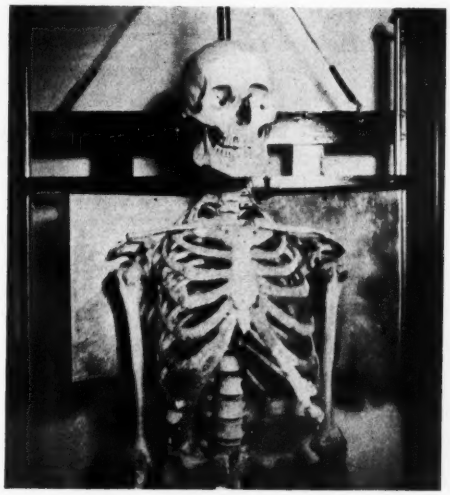


Fig. 9.

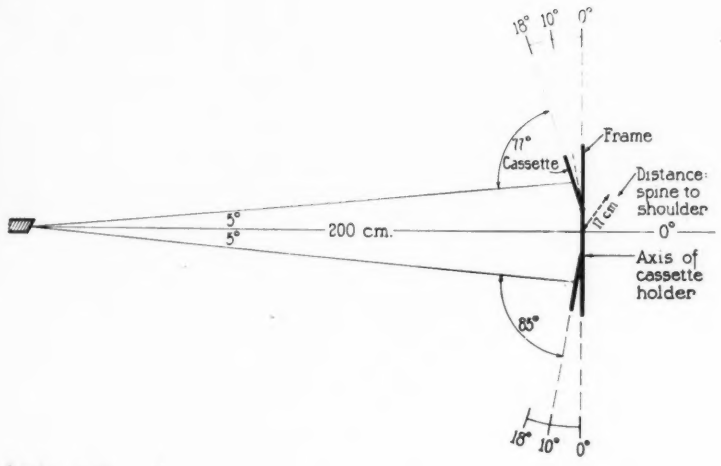


Fig. 10.

To avoid these difficulties, I have designed a new device which permits the taking of comparative x-rays of both shoulder joints of the sitting patient, without distortion, under identical conditions, with one exposure or, without moving the patient, in two exposures (Fig. 7).

In a metal frame, two cassette holders are fixed in such a manner that they can be moved horizontally, in order to adjust the cassettes to the distance of both shoulder joints in every case (Fig. 8). The

two cassette holders consist of small metal frames which are made to receive an 8 × 10 cassette. Each holder revolves around a vertical axis; their angle with the frame can be fixed at any desirable degree. The cassette holders of the right and left side have to be fixed at corresponding angles.

The large frame containing the cassette holders moves vertically on two pillars, and can be adjusted to the height of the patient.

The patient sits on a chair, the median plane of his body corresponding to the vertical mid-line of the frame (Fig. 9). The cassette holders are brought in the right position in vertical and horizontal directions; the distance of each cassette-center from the mid-line of the whole frame corresponds to the distance of the patient's shoulder joints from his spine. When the patient sits leaning with his back against the frame, the upper arms vertically downward, forearms resting in the desired position (as a rule, in the coronoid plane), and hands on the thighs, the one cassette is turned round the vertical axis of the cassette holder until it is as near to the body as possible. The other cassette is then fixed at the same angle.

For the majority of cases, one exposure suffices for taking comparative x-ray films of both shoulder joints. In order to eliminate undue distortion, especially in an obese patient in which case the part of the shoulder girdle is removed from the film, we take these views with a focus-film distance of two meters (6.5 feet). Though the center beam is not used in such a case, the deviation is so slight that it can be neglected; all the more so as the angle between the cassette holder and the frontal plane in most cases does not exceed 10 degrees. The diagram shows that the angle of incidence is only plus/-minus 5 degrees from a right-angle (Fig. 10). The exposure time was about 5 seconds by 35 ma. and 54 kv.

For a separate exposure of each shoulder joint, the exposure is taken in the same manner by shifting the tube correspondingly to the left or right without moving the patient.

This arrangement is so simple that it is not difficult to study and compare both shoulder joints in every desirable degree of abduction, adduction, elevation, and internal and external rotation.

In suggesting the incorporation of the above two methods in the routine standardized technic, which is so important for the successful running of the x-ray department, I would conclude by emphasizing that it would nevertheless be a mistake to attempt any schematization. It is particularly in the roentgenology of the shoulder girdle that what I have called "search with x-rays" is at times indispensable. Here, the postero-anterior exposure and oblique views, shifting the tube, especially in the vertical direction upward and downward, is indicated, and, sometimes, a close-up with a film-focus distance of from 30 to 40 cm. may give additional information.

REFERENCES

1. JORDAN-NARATH: Röntgenpraxis, 1933, p. 686.
2. IDEM: RADIOLOGY, May, 1934, **22**, 645 (abs.).
3. IDEM: Year Book of Radiology, 1934, p. 95 (abs.).

FLAT FOOT

A CONSIDERATION OF THE ANATOMY AND PHYSIOLOGY OF THE NORMAL FOOT, THE PATHOLOGY AND MECHANISM OF FLAT FOOT, WITH THE RESULTING ROENTGEN MANIFESTATIONS

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THE condition of flat foot is of such prevalence as to render proper diagnosis, as a prelude to treatment, of first importance. In this paper, the writers, in the hope that it may be of interest and value, submit for consideration the roentgen findings.

As an aid to diagnosis and adequate interpretation of the radiographs, a brief recapitulation is perhaps desirable of the anatomy and physiology of the foot as affecting—and resulting in—the condition of flat foot.

Definition and Classification.—The term "flat foot," when properly defined, should be restricted to those cases in which the arch of the foot either touches the ground or in which it is so much lowered that it nearly touches. The diagnosis of this condition is determined by the fixed reduction or obliteration of the dome of the foot.

Classification may be made as follows:

1. *Spasmodic.* Oncoming; to be corrected by manipulation.

2. *Rigid.* No marked bony changes are present, but treatment necessitating the application of force and the use of an anesthetic to restore the dome, is required.

3. *Osseous.* Resulting from long-continued spastic flat foot, with or without definite ankylosis, fibrous or osseous, from prolonged osteo-arthritis of the tarsus, and irreducible without removing the bony obstruction.

Anatomy.—The foot is triangular in form, broad across the toes and narrow at the heel. Normally the foot is an arch supported on three piers; posteriorly by the tubercle of the os calcis and anteriorly by the heads of the first and fifth metatarsal bones. The summit of the arch is the superior articular surface of the astragalus. The anterior posterior arch is composed of posterior and anterior limbs, the former measuring approximately three inches in length, and consisting of the os calcis and the posterior part of the astragalus, while the latter measures some seven inches, and is made up of the rest of the tarsals and metatarsals. Also, the anterior limb is divided into two parts, an inner segment, consisting of the head of the astragalus, scaphoid, cuneiform, and the inner three metatarsals, and an outer one, comprising the outer segment of the os calcis, cuboid, and outer two metatarsal bones. The hind part of the foot articulates in front with the forepart at the midtarsal joint, which is in two divisions, the inner, astragaloscaphoid, and the outer, os calcis cuboid.

The anteroposterior arch may also be divided into an inner and an outer arch, the inner arch including the os calcis, astragalus, scaphoid, three cuneiforms, and inner three metatarsals; the outer arch, much lower than the inner arch, made up of the calcis, cuboid, and outer two metatarsals. The highest point of the outer arch is between the cuboid and calcaneous. When weight is borne on the foot, the outer arch becomes obliterated and comes in contact with the ground.

The os calcis projects backward into what is called the tuberosity, which forms the projection of the heel.

The subastragaloid joint (astragalo-calcaneo-scaphoid articulation) is composed of the os calcis, astragalus, and scaphoid. The under surface of the joint is formed first by the surface of the scaphoid, next by the inferior calcaneo-scaphoid ligament, by the upper surface of the sustentaculum tali,

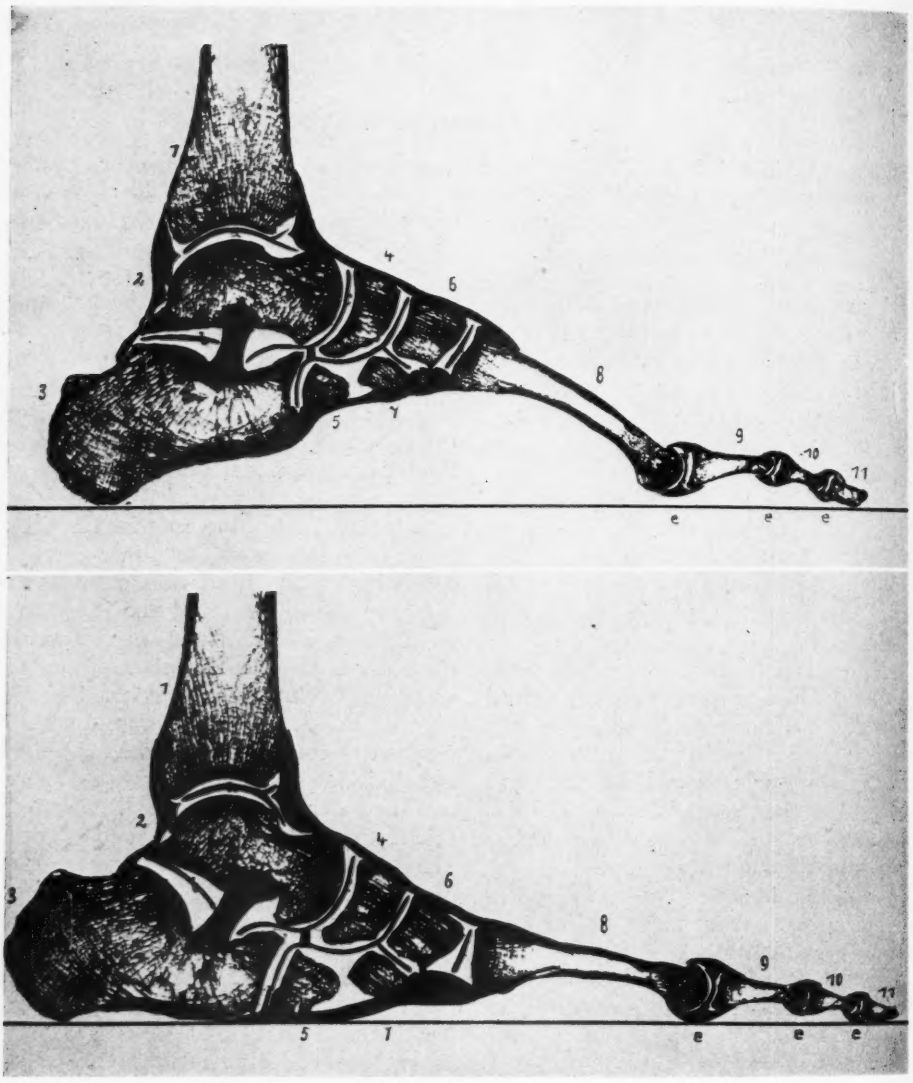

Fig. 1. Microtome section of the leg and foot. The upper represents normal arch; the lower, flattened arch. Key to numbered parts: (1) tibia; (2) astragalus; (3) os calcis; (4) scaphoid; (5) cuboid; (6) and (7) cuneiforms; (8) metatarsals; (9, 10, and 11) phalanges; (E) interphalangeal joint.

the interosseous ligament, and finally by the posterior surface of the os calcis. The inferior calcaneo-scaphoid ligament is the most important one in maintaining the integrity of the arch. In addition, in order to provide against the luxation, the joint is strengthened by three ligaments, *viz.*,

1. The interosseous astragalo-calcaneal ligament, running obliquely forward and outward between the calcaneum and astragalus.

2. Internal lateral ligament of the ankle (deltoid) which send fibers by its superior part to the sustentaculum tali and by its deep part from the tibia above to the side of the astragalus below and to the scaphoid in front.

3. External lateral ligament of the ankle,

anterior and posterior fasciculis, both attached to the astragalus, and the middle fasciculus goes to the calcaneum below.

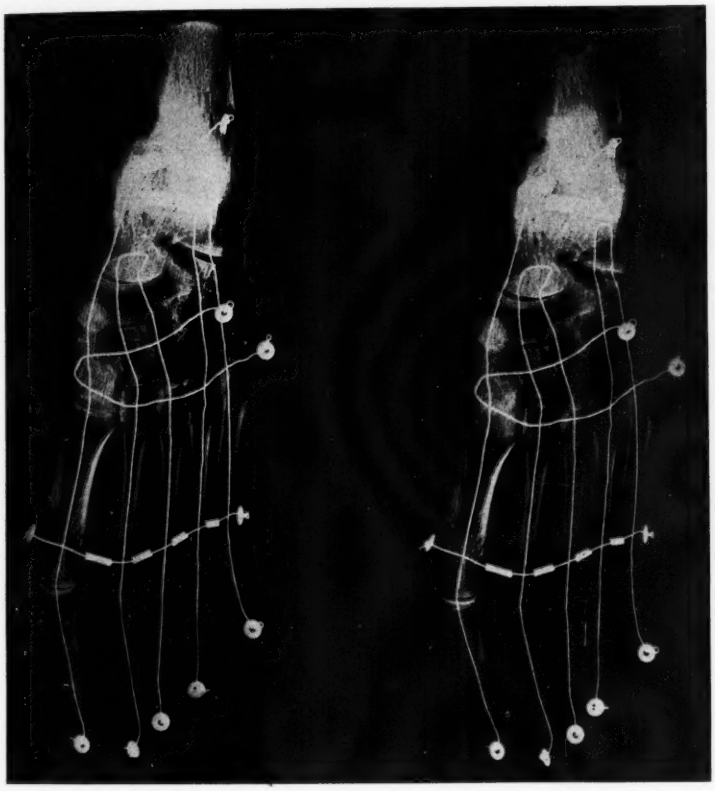

Fig. 2. Dorso-ventral views of the foot. *Left* represents the skeleton of the foot resting; *right* has been hyperflexed to give the arch position.

The instep or arch of each foot forms a half-dome and when the two feet are close to each other they form a dome, not circular but elliptical in shape, extending around the edge from the heel of one foot, round the outer border of the foot along the tread, and back along the outer border of the other foot to the heel. Considering one foot by itself, the weight of the body rests upon a half-dome, touching the ground on its outer border. The foot is stable if the body weight is so balanced that it rests on its outer edge, but if the body weight falls too near the inner side of the half-dome, there is a tendency for it to capsize inward.

The highest point and the weakest part of the longitudinal arch is at the astragaloscaphoid articulation, which is braced by strong ligaments and muscles, of which the more important is the inferior calcaneoscaphoid ligament.

The transverse arch extends across the foot from the heads of the metatarsals to the mid-tarsal region of the scaphoid. The outer end of the transverse arch is supported by the outer edge of the foot, which, through soft parts, is in contact with the ground. The inner end is supported by the inner edge of the foot, which is some distance above the ground. The anteroposterior and transverse arches are maintained not only by the ligaments but by the plantar fascia, interossei, short flexors, peronei (longus, brevis, and tertius), tibiales anticus, and posticus muscles and to a certain

extent by the abductor pollicis and abductor minimi digiti.

In talipes valgus the forefoot is abducted from over-action of the abductor minimi digiti, peroneus (longus and brevis), and is usually associated with pronation and eversion anteriorly. The angle of deflection is less than 25 degrees. The normal angle of deflection is produced by the intersection of a line from the center of the os calcis through the middle toe at the mediotarsal joint with a second line passing through the ball of the great toe, forming normally an angle of from 25 to 30 degrees. As stated, this is the normal angle of deflection, *i.e.*, the forefoot is adducted with relation to the heel from 25 to 30 degrees. If the angle is lessened by deflection of the forefoot, in an outward direction, at the mediotarsal joint, the foot is abducted and constitutes talipes valgus or flat foot.

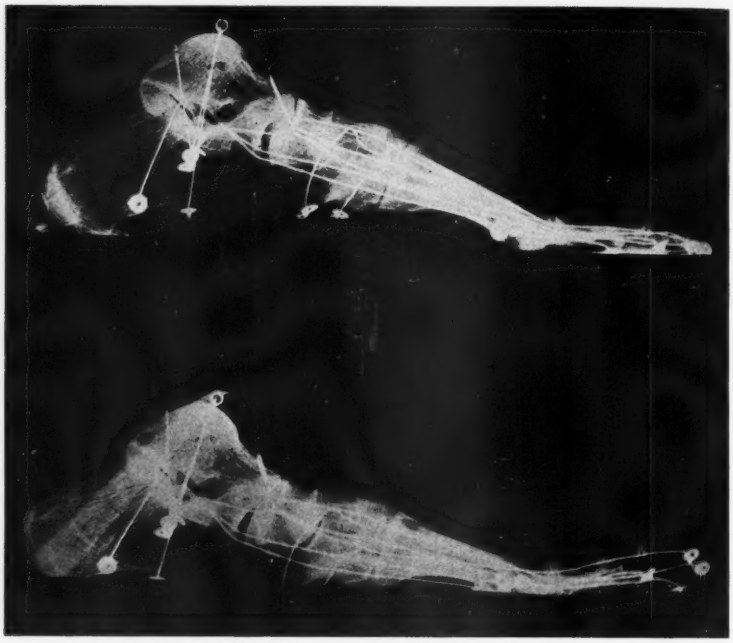

Fig. 3. Lateral views of the skeleton of the foot, the upper representing the normal arch and the lower after flattening of the foot.

The inner border of the foot should present a relatively straight line from the heel to the inner side of the great toe, from the first to the last phalanx. The concavity of the arch should be well without this line, and similarly, the front and outer border should be slightly convex.

A straight line from the center of the heel through the ball of the great toe should pass through the center of the distal end of the great toe in order to insure the proper angle of deflection of the forefoot to the heel and proper alignment of the phalanges to the metatarsal of the great toe (Meyer's line).

In the normal foot, the tubercle of the scaphoid will be found on a line drawn from the lowest point of the internal malleolus to the tubercle of the first phalanx of the great toe. In the lowered arch, the tubercle of the scaphoid will appear below this line and in an arch abnormally high, it will appear above this line (Feiss' line).

The foot is so constructed so as to combine both strength and mobility. Strength is achieved through the bones being short and solid, well compacted together in the form of a double arch, joined by strong ligaments and supported by powerful muscles.

Mobility is obtained by the bones and joints being numerous and the muscles highly specialized.

The main weight is transmitted through the internal set of the anteroposterior arch which is in relation with the tibia. The external set is in relation with the fibula.

The main function of the internal portion of the foot is support, that of the external portion is balance. The weight of the body is transmitted along the astragalus in three directions, *viz.*, backward, to the tuberosities of the calcaneum; forward, to the heads of the metatarsal bones, and laterally, toward the base of the fifth metatarsal bone.

The posterior pillar of the anteroposterior arch is short and thick. Composed of only two bones, the astragalus and os calcis, it is stiff and strong, but having but two parts, is comparatively immovable. The anterior pillar of the arch is longer and has more bones, and while not so strong against static pressure as the posterior pillar, is on account of its elasticity of specific value against dynamic (active) pressure. This is well illustrated by the fact that a fracture to the os calcis or astragalus of the posterior pillar is the ordinarily expected result when an individual leaps from a height and alights on the sole of the foot, whereas, upon such occurrence the bones of the anterior pillar escape without injury. In this situation, the internal part of the foot yields more readily than the external, for the latter is practically in contact with the ground, while the former part has, as its support, ligaments and muscles, and when these give way, it is the inner side of the foot which sinks. This condition is also contributed to by the position of the tuberosities of the os calcis with reference to the ankle joint, for they are not directly beneath it but somewhat to its outer side.

Only in the subastragaloid joint does any considerable motion take place, while a lesser amount occurrs at the midtarsal joint. The contiguous tarsal bones are joined by numerous band-like capsular and interosseous ligaments which allow a limited amount of movement between them. In the aggregate these movements are considerable and make the foot as a whole quite flexible.

The three principal axes of movement of the foot are:

(1) Transverse, through the lower part of the astragalus. The movements of the ankle are dorsal and plantar flexion.

(2) Longitudinal, parallel with the long axis of the foot, through the subastragaloid joint. The motion here is in the direction of inversion and eversion of the sole.

(3) Vertical, through the medeotarsal joint, with motion producing abduction and adduction of the forefoot.

In the upright position, the highest point is that between the occiput and atlas, and the lowest that of the ankle. To enable the body when upright to be in a state of rest with the least amount of exertion, these joints are placed almost vertically one above the other. A vertical line through the center of gravity must fall within the arch of the foot as its base of support. The body is in the position of greatest stability when the center of gravity passes through the astragalo-scaphoid joint midway between the two points of the tubercle of the calcaneum posteriorly, and the head of the first metatarsal bone anteriorly. For lateral equilibrium, in the upright position, the center of gravity falls midway between the ankles of the two feet.

The foot at rest is plantar flexed adducted and rotated slightly inward. During movement, the position of the bones is controlled by the muscles; when at rest, their position is governed by the ligaments, for the muscles are then relaxed. The weight of the body acts as a constant downward force, a situation of potential injury, were it not neutralized and balanced in the bones, ligaments, and muscles. Weakened ligaments in the foot is the primary cause of flat foot, for these ligaments give way when a standing person, in fatigue, assumes a position of rest, causing the muscles to relax and the joints to become extended—thus thrusting the body's weight upon these

weakened ligaments which, because of their condition, fail in their duty of support.

When the long or longitudinal axis of the os calcis is altered as it is in lowering of the dome of the foot, the prominence of the heel is altered. In flat foot, the axis is changed from forward, downward, and outward, to forward, horizontal, and inward, resulting consequently in prominent heels.

The characteristic of the walk is the abduction, and listing of the foot to the inner side. Hence the soles of shoes are inevitably more worn along this side; also, the counter on the inner side may overrun the heel.

The dorsum of the trochlear surface of the astragalus increases in prominence, as does also the external malleolus. The altered direction of the long axis of the foot through much abduction of the forefoot causes the external malleolus to appear in substantial alignment with the internal malleolus, and, in aggravated cases, may even seem in advance of the internal malleolus. In neither case has any actual changes taken place in the relation of the tibia to the fibula.

The dome of the foot is obliterated. The eversion and rotation on the subastragaloid axis has so altered the position of the os calcis that its external inferior tubercle is lifted from the supporting surface, and an articulation may be formed between the external surface of the bone and the external malleolus. The anterior part of the os calcis has been abducted. The external arch with the entire dome has been lowered and the eversion has so rotated the bones that the cuboid is on about the same horizontal plane as the upper part of the head of the astragalus. The superior faces of the internal cuneiform and the first metatarsal and the upper part of the head of the astragalus look inward.

It is this rotation of the foot which throws the external malleolus into such prominence and correspondingly decreases that of the internal malleolus. The abduction of the forefoot gives the external malleolus the appearance of having been moved to a position in advance of its normal one. The scaphoid may be greatly altered in shape, and its tuberosity look downward instead of inward, thus giving an altered direction to the tibialis posticus. The greater part of the inner surface of the head of the astragalus is uncovered as it is depressed and rotated inward, while the scaphoid in relation to it is displaced upward and outward. Exuberant bone may be present on what is now the outer and upper part of the head of the astragalus and also about the cuboidal facet of the os calcis.

The forefoot is abducted from overaction of abducto minimi digiti and peroneus longus and brevis, usually associated with pronation and eversion and the angle of deflection is less than 25°. The weight of the body transmitted to the foot tends to flatten the anteroposterior arch. In this process, either the astragalus is moved up, up-luxating, or the ligaments stretch or rupture, allowing the two pillars of the arch to separate.

There are three stages of the process of talipes valgus, *viz.*: (1) eversion; pronated foot; muscles give way first; foot everts mainly at subastragaloid joint; (2) descent of tarsal arch or flat foot; (3) later by a more complete eversion of pes valgus.

The basic explanation of flat foot is manifest. In short, unable to support the body weight on the weakened muscles, the patient relaxes, throwing the unaccustomed burden on the ligaments. These inevitably give way, the arch descends, and flat foot results.

X-RAY FINDINGS

Because of the bone and joint changes in flat foot of the spasmodic and osseous type, no upright posturing is needed.

In pronation of the calcaneum, the shadow of the lateral process of the tuberosity is absent.

Normally the free dorsum of the distal articular end of the astragalus forms a slightly concave line. Swelling ridges and formation of processes are all pathological, caused by the abnormal form of the whole

arch of the foot. The posterior process of the astragalus becomes larger and more irregularly edged.

A broad gaping joint fissure on the dorsum between the astragalus, scaphoid, and cuboid indicates flat foot. When the body weight is placed on the foot, the fissure becomes narrower.

In flat foot, the articular edges frequently appear raised—a condition which is always combined with a bony swelling at the articular ends of the bones.

In the normal foot, the plantar view of the scaphoid bone takes the form of a crescent. In flat foot, it is more wedge-shaped.

On the inner side of the tuberosity of the ischium there is developed a considerable button-like thickening of the bone. Due to flat foot, an external gait, and flat pelvis, an exostosis is formed at the origin of the gracilis tendon. The pelvis is turned from the normally inclined position, and elevated to the flat position at the anterior edge.

Thanks are due to the Clay-Adams Co., of New York City, who were kind enough to furnish us with the microtome section and the skeletons of the foot, which are used in this article.

130 Henry St.

REFERENCES

1. Davis, G. G.: Applied Anatomy. J. B. Lipincott Co., Philadelphia, 1934.
2. Dunn, H. L.: Status of Human Arch when Subjected to Body Weight. Military Surgeon, June, 1923, **52,** 567–628.
3. Jones, Sir Robert, and Lovett, R. W.: Orthopedic Surgery, Second ed., William Wood & Co., New York, 1929.
4. Köhler, A.: Roentgenology. Translation by Arthur Turnbull. William Wood & Co., New York, 1928.
5. Nutt, J. J.: Diseases and Deformities of the Foot, Second ed., E. B. Treat & Co., New York, 1925.
6. Slomann, H. C.: Demonstration and Analysis of Calcaneo-navicular Coalition by Roentgen Examination. Acta Radiologica, 1926, **5,** 304–312.
7. Taylor, R. T.: Surgery of the Spine and Extremities. P. Blakiston's Son & Co., Philadelphia, 1923.

ROENTGEN MENSURATION BY STEREOROENTGENOMETRY[1]

By CLAYTON R. JOHNSON, M.D., *Los Angeles*

STEREOROENTGENOMETRY is a descriptive name for a method of roentgen measurement whereby the solid dimensions of a radiopaque object may be determined from its stereoscopic radiograms. The basic principle involved is that known as "the Cross-thread Method of Localization," described by Mackenzie-Davidson, in 1896 (1), who established the fact that it is possible and practical to reconstruct, by mechanical means, a phantom image of an object from its shadows on stereoscopic radiograms.

Later, in 1911, Manges (2), using the same principle, measured the bony pelves of pregnant women.

On previous occasions (3, 4, and 5), the author has described his original apparatus and method for roentgen measurement of radiopaque bodies. The method has proved practical and accurate for pelvimetry, for the localization and measurement of foreign bodies, for the measurement and localization of sinus tracts filled with opaque media, and for other similar diagnostic problems.

[1] The stereoroentgenometer is being manufactured and distributed by the Standard X-ray Co., Chicago, Illinois.

THE PRINCIPLE OF STEREOROENTGENOMETRY

In Figure 1-*A*, XY represents a radiopaque object somewhere in space between the target of the tube A and the film FF'. When the focal spot of the tube is at A, the shadow of XY will be cast on the film as $AX\,AY$. The target of the tube is then shifted to position B and the shadow XY is cast on the film as $BX\,BY$. The distance from A to B is known, the distance from A to FF' is known, the position of the film FF' with relation to the tube position A and B is known, therefore, it becomes a simple procedure to reconstruct a phantom image of XY in the following manner.

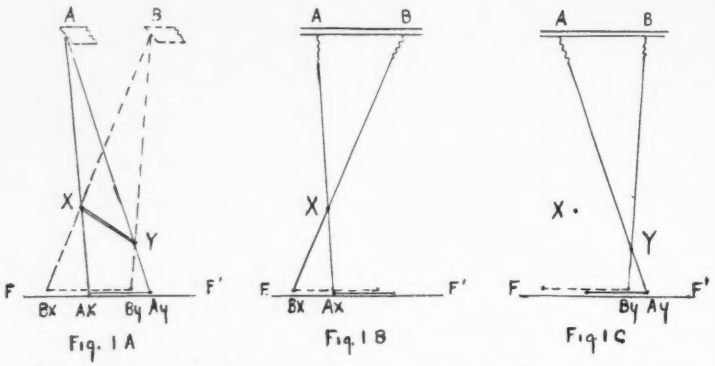

Fig. 1. Illustration of the principle of stereoroentgenometry. See text for description.

In Figure 1-*B*, the apparatus (the stereoroentgenometer) is so constructed that the positions A and B and FF' are in identical relationship as that of Figure 1-*A*. Flexible wires are stretched from A to AX and from B to BX. The point at which the wires cross will be the location of X in space with relationship to the film when the radiogram was made. This point is fixed by means of a pointer.

In Figure 1-*C* the wires are stretched to

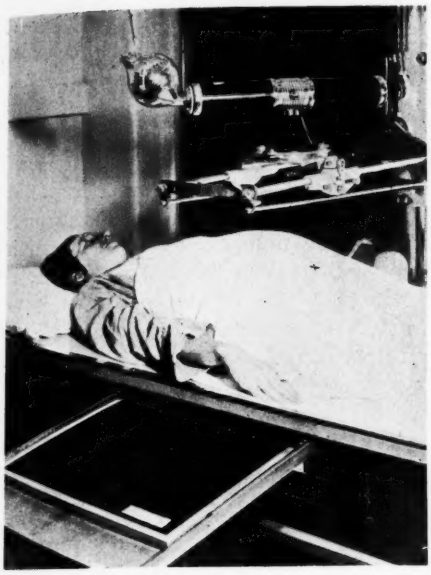

Fig. 2. The patient lies in a comfortable supine position and stereoradiograms are made. Any technician with average skill can make these radiograms. The Bucky tray has been pulled out to show the cassette and special marker.

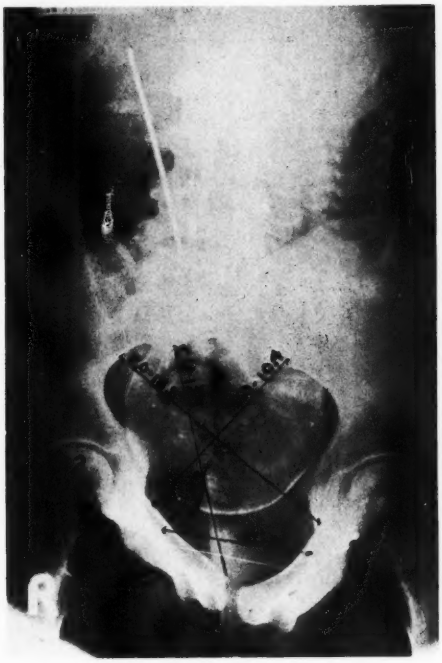

Fig. 3. Illustration of an obliquely contracted or Nagele type of pelvis. All diameters of the inlet, outlet, and fetal head are readily obtainable. Stereoradiograms are available for locating anatomical landmarks for measurement, for determining the position of the head, and for studying the contour of the pelvis.

BY and AY; this locates the point Y in space. We have now constructed a phantom image of the object XY in space, and its size may be measured directly with a rule. The distance XY may represent the true conjugate of a pelvis, the diameter of a bullet, or the size of a sinus tract filled with opaque media.

ROENTGEN PELVIMETRY

Since the introduction of the method in 1927, the author has used the system successfully in several hundred cases of roentgen pelvimetry and some very definite conclusions have been drawn. Although practically every type of pelvic deformity described has been discovered in these examinations, the percentage of significant disproportion between the fetal head and the maternal pelvis is probably less than 1 per cent and certainly not so frequent as suspected from clinical examinations upon which elective operative procedures are instituted.

The technic of examination for pelvimetry has had no important changes since that described on previous occasions. The patient lies in a comfortable supine position and stereoradiograms are made (Fig. 2). Any technician with average skill can make these radiograms. As applied to pelvimetry, any desirable diameters (Fig. 3) of the pelvis and fetal head are readily obtainable. Stereoradiograms are at the same time available for study as to the general contour of the pelvis and position of the fetal head. Any method of roentgen pelvimetry which provides less information is inadequate.

From experience, it has been found practical to determine the true conjugate, the right oblique, and the left oblique diameters of the inlet. Any true conjugate above 10.5 cm. should be considered adequate. At the outlet, the bis-ischial and posterior sagital diameters are most important.

Fig. 4. The stereoroentgenometer, a practical device for roentgen measurement of the radiopaque objects.

When the sum of these diameters are 17 cm. or more, no difficulty should be experienced with the normal fetal head.

COMMENT

The skill in interpretation of the findings is not difficult for anyone who can qualify as a roentgenologist. Roentgen pelvimetry opens a new field of great practical service for the roentgenologist. A well constructed, workable instrument (Fig. 4) at comparatively low cost is now available.[1] It gives the roentgenologist a new, practical tool, universal in application in those instances wherein it is desirable to know the solid dimensions of radiopaque skeletal parts or objects within the human body.

REFERENCES

(1) DAVIDSON, SIR J.: Localization by X-rays and Stereoscopy. Hoeber, New York City, 1916.
(2) MANGES, W. F.: Description of Method of Measuring Female Pelvis. Am. Quart. Roentgenol., April, 1911.
(3) JOHNSON, C. R.: Mensuration and Localization by Means of Roentgen Ray. RADIOLOGY, June, 1927, **8**, 518–521.
(4) IDEM: Stereoroentgenometry of the Female Pelvis. Trans. Section on Obstetrics, Gynecology, and Abdominal Surgery, A. M. A., 1929.
(5) IDEM: Stereoroentgenometry: A Method for Mensuration by Means of the Roentgen Ray. Am. Jour. Surg., January, 1930.

CONGENITAL BRONCHIECTASIS IN CHILDREN

By GEORGE S. REITTER, M.D., *East Orange, New Jersey*

A SURVEY of the literature reveals that there have been comparatively few cases of congenital bronchiectasis reported since Lænnec, in 1819, first drew attention to this condition. There seems to be little or no disagreement among some recent writers that bronchiectasis in children is of congenital origin. The clinical aspects are well known and need not be described. The pathologic-anatomic characteristics, however, should be discussed.

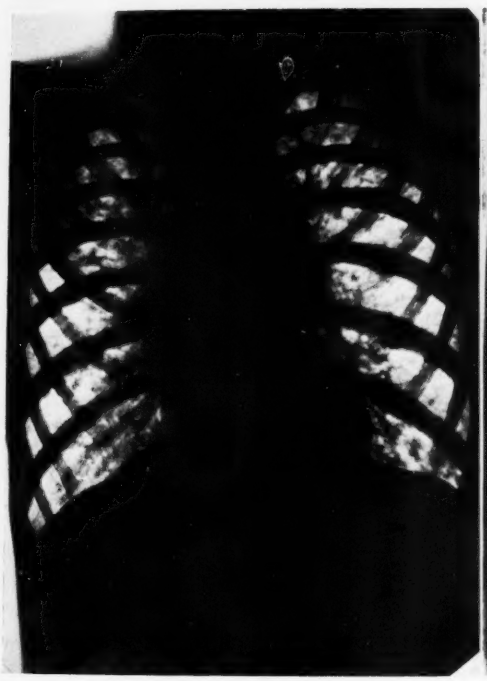

Fig. 1.

Fig. 2.

Figs. 1 and 2. Congenital bronchiectasis. Multiple globular cavitations are present throughout both lungs, with considerable infiltration along the bronchi.

Anatomists admit four types of bronchial malformations: (*a*) pulmonary agenesia and hypoplasia; (*b*) fetal bronchiectasis, including polycystic lung; (*c*) formation of bronchi in countless numbers, and (*d*) chondromas. Although the usual case of bronchiectasis in children is considered to be the result of long-continued coughing, and there is little doubt that infantile bronchopneumonia and whooping cough do modify the bronchial walls and destroy their elastic armor thereby causing a secondary dilatation, one must always consider that the accidental malady is often only the occasion which brings out a latent congenital lesion or that a congenital lesion may be present and is aggravated by an accidental bronchopneumonia. A congenital factor must be admitted with surprising frequency in any case. The pathologic characteristics are hyperplasia and rich vascularization, marked mutilation of the bronchial muscles, elastic tissue, and cartilages, whether the lesions are

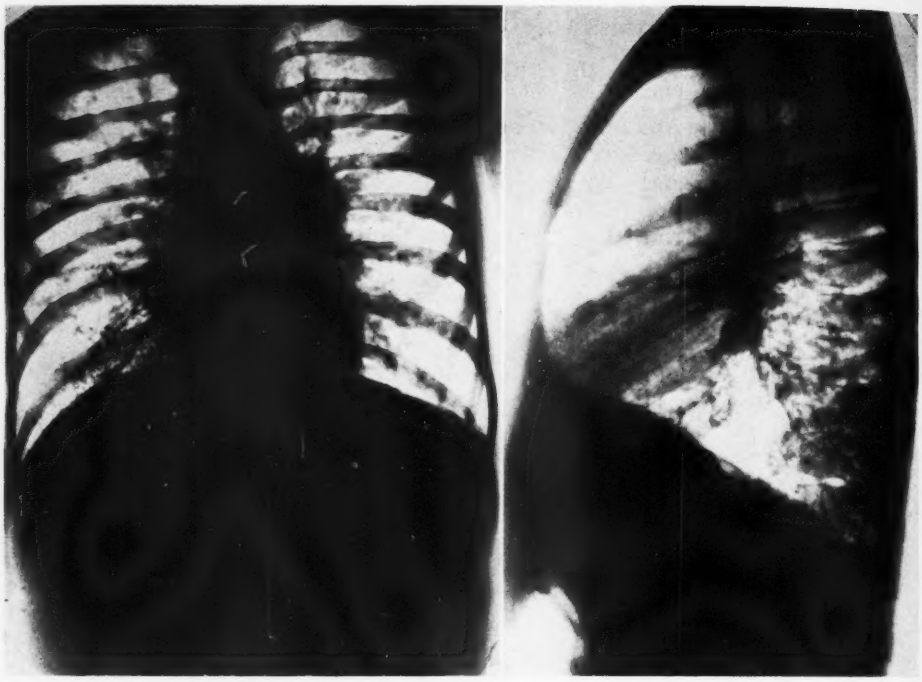

Fig. 3. Fig. 4.

Figs. 3 and 4. Same case, after instillation of lipiodol into the right lower lobe.

confined to one lobe or involve the entire lung.

A case was admitted to the Essex County Isolation Hospital with the diagnosis of pulmonary tuberculosis from a County Tuberculosis Clinic. The patient, a white female of nine years, gave a history of having had chicken pox, measles, and mumps. The mother stated that she had always had some cough, which at times was productive, and that she had never been a robust child.

The following were the positive clinical findings: A poorly developed and poorly nourished child, not acutely ill. The tongue was coated, the skin warm and dry, and the muscles of the extremities had a wasted appearance. The fingers were clubbed. The cheeks were flushed. The chest was poorly developed, with retracted interspaces, and had marked osteopulmonary arthropathy. There was some tactile fremitus throughout, with the percussion note dull over the left upper chest posteriorly. There were loud crackling râles over the entire chest, more marked in the apices and the upper portions of the lungs. The heart was normal. The abdomen was protuberant and hard but without muscle rigidity or tenderness. There was a nonproductive cough and profuse night sweats. Eight tuberculin tests were negative. Repeated sputum tests and stomach washings were negative for tubercle bacilli.

The first roentgenologic examination was made after one week in the hospital; the second was made with lipiodol given by the bronchoscopical method at the end of a month.

Two weeks later, the liver was found to be hard and descended to about three fingers' breadth below the costal margin. This was believed to be an amyloid infiltration. The right side of the chest drooped. Râles were present throughout the entire chest, both on inspiration and expiration;

expiration was prolonged. The clinical impression at this time was that the patient had a right bronchiectasis, a second degree emphysema, and an amyloid liver.

At all times the patient ran a spiked temperature. Her total gain in weight during the six weeks in the hospital was four pounds. Postural drainage was tried for ten minutes every other day. The expectoration was a greenish muco-purulent material, which at one time was tinged with blood, probably due to the force with which it was brought up, for she often vomited food of the previous meal in these paroxysms.

The interest in this particular case arose from the problem of its differential diagnosis, *i.e.*, tuberculosis or congenital bronchiectasis. The patient had been classified as a case of active pulmonary tuberculosis by the County Tuberculosis Clinic. There was no history of tuberculous contacts in the family, and there were eight negative Mantoux tests. The fibrosis and infiltration in the bronchi, together with the enlarged peribronchial lymph nodes, would suggest that the bronchiectasis was secondary to tuberculous lesions. The absence, however, of a definite clinical basis of tuberculosis would rule out this positive factor. The patient never had had whooping cough, pneumonia, or any other acute respiratory infection, which have been the commonly accepted causes of bronchiectasis. I am inclined to agree with Krampf, Saye, Herms and Mumme, and Lereboullet that there is a congenital basis for most cases of bronchiectasis in children, and that the diagnosis in this case should be congenital bronchiectasis.

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REFERENCES

(1) KRAMPF, F.: Solitary Cysts of Lung and Congenital Bronchiectasis. Deutsche Ztschr. f. Chir., 1929, **220,** 229.

(2) HERMS, J., and MUMME, C.: Congenital Bronchiectasis and Cystic Lungs. Beitr. z. Klin. d. Tuberk., 1931, **77,** 701.

(3) SAYE, L.: Congenital Bronchiectasis in Twin Sisters. Ann. de med. int., January, 1932, **1,** 13–20.

(4) LEREBOULLET, PIERRE: The Congenital Factor in Bronchiectasis in Children. Paris Méd., Feb. 17, 1934, **24,** 157.

DEVELOPMENTAL CHANGES IN THE VERTEBRAL ARTICULAR FACETS

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GROWTH and differentiation in any part of the human organism usually progress in a definitely predictable manner. Such governed alteration in size and shape is well exemplified in the development of the vertebræ. Clinical experience has taught us that serious mechanical or metabolic disturbances are required to alter this pattern of growth. Bending is seen, more commonly, in the long bones, but in all diseases leading to osseous deformity there is a constant attempt on the part of the reparative forces of the body, probably through mechanical stimuli, to approach the normal contour of the bone.

Fig. 1. The vertebral column of a child two years of age, showing congenital abnormalities of the spine. There is a wide separation of the pedicles in the mid-dorsal region, and complete absence of the pedicle on the left side in the lumbar region.

Abnormalities in the vertebral articular facets may be found at birth, as Putti (1) and Wierszejewski (2) have shown. There may be complete absence of the pedicles and articular facets, or there may be wide lateral separation of the laminæ, *e.g.*, spina bifida, causing the facets to be useless as joints. A more common change, especially in the lumbar region of the spine (3), is a variation in the shape and directional slant of one or both articular facets of a vertebra. One articular facet may be of the normal, crescentic type, while the other may be flat with a varying axis of the articular surface (4). Abnormalities of this sort lead to a difference in the relative stability of the two sides of the vertebral column, with changes in contour appearing in adult life. Strain of the back (5) and scoliosis (6) have accompanied such irregularities of structure (Fig. 1).

Changes in the vertebral articular facets occur from many causes during growth. This study was suggested by the changes observed in the articular facets in roentgenograms of children with scoliosis. An attempt was made to determine what structural alterations occurred in the articular facets of the spinal column before maturity was attained. Five hundred roentgenograms of the spinal column in children were studied to determine the presence and frequency of abnormalities in the vertebral articular facets. In the Warren Museum of the Harvard Medical School, an examination was made of the skeletons of children, as well as those of adults, with deformity. Portions of the dorsal spine were removed routinely at 50 autopsies upon children, and the articular facets of these specimens were studied macroscopically and microscopically.

The vertebral articular facets attain functional maturity as spinal joints at the seventh to the eighth month of fetal life. They are recognized in the cartilaginous extensions of the vertebral anlage in 14-millimeter embryos, and are found as separated, overlapping articular surfaces in 50-millimeter embryos (7). Their appear-

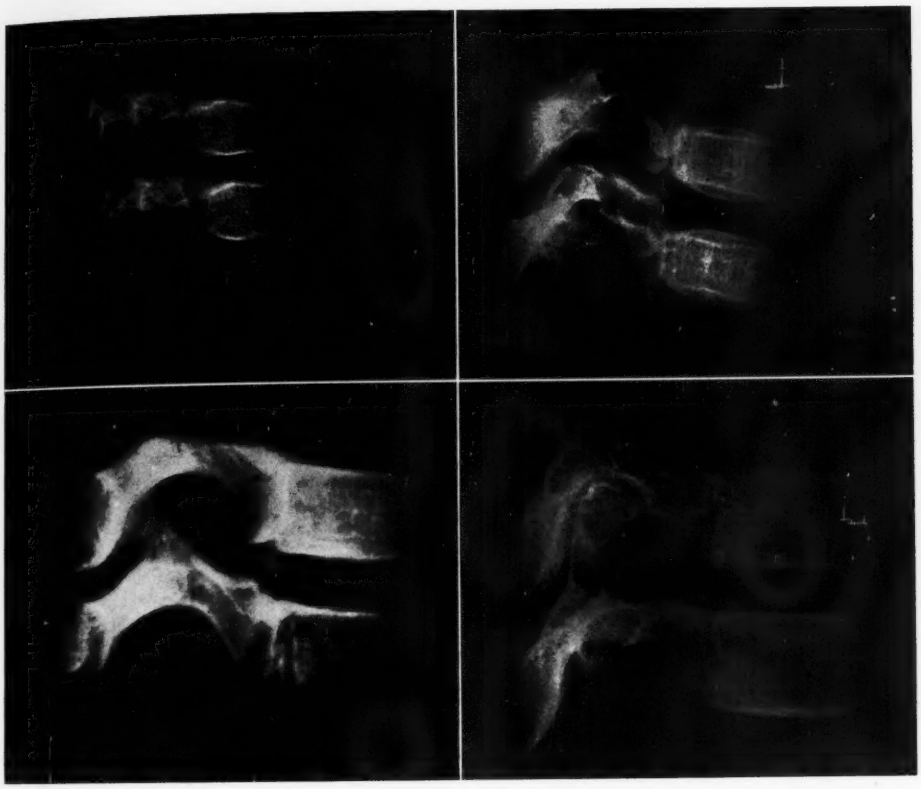

Fig. 2. Lateral roentgenograms of the dorsal vertebræ: (*A*) (*upper left*) at birth; (*B*) (*upper right*) 6 months; (*C*) (*lower left*) 1 year; (*D*) (*lower right*) 2 years. Well calcified articular facets are seen first in *C*.

ance in roentgenograms during infancy varies widely; they are usually first seen between six months and two years of age. Microscopic sections made through the vertebral articular facets of children dying in early infancy show an osseous nucleus occupying the central portion of the facet, but this amount of ossification is not sufficient, usually, to produce a shadow in the roentgenogram (Fig. 2). Clear definition of the articular margins is not commonly found before the age of eight.

Because of the peculiar contour of the vertebræ, roentgenologic interpretation of changes in the articular facets is often difficult in roentgenograms of the spinal column taken in the customary manner. Special methods for obtaining roentgenograms of the articular facets have been reported by Lange (8) and by Ghormley and Kirklin (9). In the upper cervical spine, the articular facets are best shown in roentgenograms taken through the open mouth. In the lower cervical region, lateral views provide a good picture of the facets. For the dorsal spine, rotation dorsally from 15 to 20 degrees from the true lateral view is suggested. In the first to the fourth lumbar vertebra, the articular facets are shown fairly well in anteropos-

TABLE I.—ROENTGENOLOGIC CHANGES IN SPINAL ARTICULAR FACETS IN CHILDREN

Changes	No. of cases
Negative	203
Spina bifida occulta	89
Asymmetry of facets (on the two sides)	48
Elongation of tip of facet (sharpening)	23
Articular surfaces not parallel	22
Cases studied	500

In children, ankylosis of the articular facets cannot be ascertained with certainty in roentgenograms.

Fig. 3. The lumbar spine, with asymmetry of articular facets and osteoarthritis, and marked bony overgrowth about the facets.

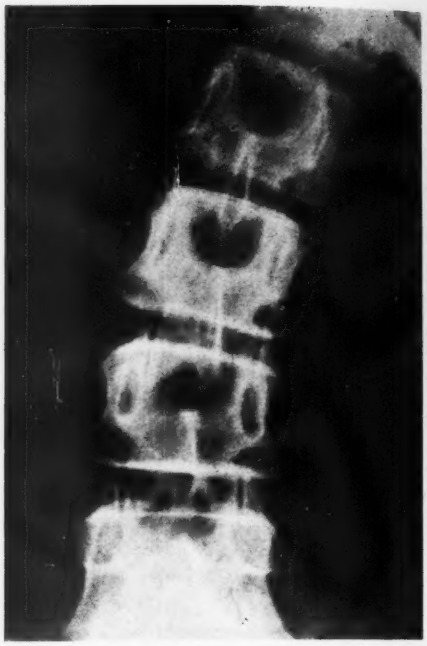

Fig. 4. Child of 12 years with marked lordosis and asymmetry of the lumbosacral facets. Note the elongation of the facets on the right.

terior views. For the lumbosacral region, a diagonal view with the patient rotated from 45 to 60 degrees from the true lateral is advocated.

While special technic gives a less distorted and more clearly defined picture of the vertebral, articular facets, much can be learned from anteroposterior and lateral views of the spine. In good roentgenograms, the outlines of the articular facets can usually be determined on close scrutiny when the shadow of the pedicles or vertebral body is superimposed. Table I summarizes the findings in a study of 500 anteroposterior and lateral roentgenograms of the spine in childhood. Many more variations would probably have been found in older groups and if special roentgenograms for the articular facets had been taken.

The most common finding in roentgenograms is spina bifida. Somewhat less common is an asymmetry of the articular facets chiefly at the lumbosacral junction. Here, further changes take place in adult life, probably in an attempt to increase vertebral stability (Fig. 3). Goldthwait (10) and Ghormley (11) have shown that serious disturbances can follow such changes. With persisting anteroposterior and lateral deviations of the spine, developmental changes in the articular facets must, of necessity, occur with growth. They are recognized chiefly as a twist or an elongation (a "sharpening") of the tip of the articular facet (8) (Fig. 4).

In specimens of the spinal column mild asymmetry of the laminæ and slight changes in the length and directional slant of the articular facets are often found. Both in the milder anteroposterior and lateral deviations of the spine, and in the more severe scoliosis and kyphosis accompanying out-spoken disease, changes are found in the vertebral articular facets in fixed preparations. In the living, these changes are often not perceptible in roentgenograms. In kyphosis, there is first seen an increased anteroposterior inclination of the facets, with a fairly constant maintenance of the parallel position of the

Fig. 5. The spine of a boy 21 years of age, who had tuberculosis of the spine since the age of seven. There is fusion of the articular facets at the apex of the kyphos.

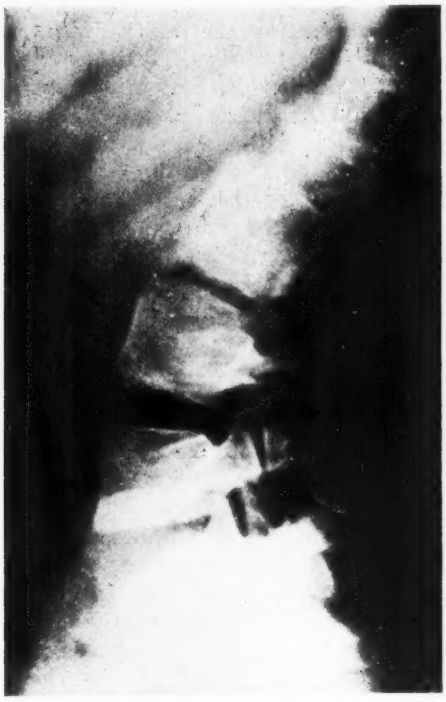

Fig. 6. Roentgenogram of a lumbar spine, of a child seven years of age, with extreme lordosis. There is disalignment of the articulating surfaces of the facets.

opposing articular surfaces. With marked increase in the deformity, *e.g.*, tuberculosis, fusion of the articular facets about the apex of the kyphos may occur (Fig. 5).

In lordosis, there is a greater tendency to disalignment of the articular surfaces (Fig. 6). In older individuals this is supplemented, not infrequently, by osseous proliferation about the margins of the facets, at times producing a hooked process which greatly limits motion. In scoliosis, much less distortion of the facets is seen than would be expected. In prepared spines with moderate scoliosis, the contour, directional slant, and functional integrity of the facets are maintained surprisingly well. In the severe curves, ankylosis of the articular facets occurs at the apex of the curve. In rheumatoid arthritis, involving the spine both in adults and in children, there is early ossification of the articular capsule, followed more slowly by ankylosis of the articular facets.

These changes, however, do not lead to noticeable changes in the internal bony architecture of the articular facets. Microscopic study of the articular facets obtained at autopsies upon children showed no distinct changes in the internal architecture of the bone.

These developmental changes in the vertebral articular facets may come on slowly or rapidly. In metabolic disturbances, as in rickets, in diseases leading to the destruction of bone and after severe trauma, they can occur in a short space of time. In postural deformities and in scoliosis they arise more slowly. Symptoms usually appear only after fairly extensive deformity of the articular facets has occurred (11). At first there is only slight interference of the functional activity of the spine, which steadily becomes more marked with increase of the deformity.

In roentgenograms, as Lange (8) has shown, one of the earliest changes is a pointed appearance of the tip of the articular facet, instead of the usual rounded con-

tour of the end of the facet. In anteroposterior disturbances in vertebral alignment, the parallel position of the articular surfaces of the facets is changed, but secondary arthritic changes develop very slowly. In scoliosis, the articular surfaces are pressed firmly together on the concave side but are separated on the convex side. Tortion of the vertebral bodies may produce a sagittal or frontal separation. Fractures usually produce easily observable shadows if the roentgenograms are taken in a special manner to show the articular facets. Occasionally, as was shown in one roentgenogram studied, a congenital separation of the tip of the articular facet may be present. The absence of the usual signs of fracture will help in the diagnosis of this condition. Dislocations of the facets may occur after slight or more severe injuries (12). In such injuries, structural changes in the articular facets develop rapidly if reduction is not accomplished.

The seriousness of these deformities of the vertebral articular facets and the symptoms which they produce vary widely. It is evident that their presence at times prevents correction of spinal deformity and limits vertebral motion. That they can lead to serious neurologic symptoms has been shown by Gunther and Kerr (13), and by Ghormley (11). The less severe changes in the articular facets often lead to osteoarthritic changes by the mechanical disalignment and by the interference which they produce in articular motion.

CONCLUSIONS

(1) Deformities of the vertebral articular facets occur frequently with spinal deformities and with diseases and injuries involving the vertebræ.

(2) These deformities are best shown in roentgenograms by special technic but are often visible in ordinary anteroposterior and lateral roentgenograms of the spinal column.

(3) The usual deformities of the facets found in roentgenograms and in cleared specimens are: (*a*) disalignment of the articulating surfaces; (*b*) proliferative changes, either hook-like projections about the margins or an elongation of the tip of the articular facet; (*c*) ankyloses of the facets.

(4) These changes, although mild and symptomless in childhood, may hinder correction of a spinal deformity, and may lead to the development of osteo-arthritis about the facets and irritation of the spinal nerve roots.

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REFERENCES

(1) Putti, V.: Die angeborenen Deformitäten der Wirbelsäule. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1910, **15,** 65.

(2) Wierzejewski, I.: Über angeborene knocherne Veränderungen der Wirbelsäule. Ztschr. f. orth. Chir., 1929, **50,** 603.

(3) Odgers, P. N. B.: Lumbar and Lumbosacral Joints. Jour. Anat., 1933, **67,** 301.

(4) Goldthwait, J. E.: Variations in the Anatomic Structure of the Lumbar Spine. Am. Jour. Orth. Surg., 1920, **2,** 416.

(5) O'Reilly, A.: Abnormalities of the Lower Part of the Back. Jour. Am. Med. Assn., 1927, **89,** 1128.

(6) Adams, Z. B.: Importance of Articular Processes in Production of Scoliosis. Boston Med. and Surg. Jour., 1910, **162,** 569.

(7) Keibel, F., and Mall, F. P.: Human Embryology. J. B. Lippincott Co., Philadelphia, 1910.

(8) Lange, M.: Die Wirbelgelenke. F. Enke, Stuttgart, 1934.

(9) Ghormley, R. K., and Kirklin, B. R.: Oblique View for Demonstration of Articular Facets in Lumbo-sacral Backache and Sciatic Pain. Am. Jour. Roentgenol. and Rad. Ther., 1934, **31,** 173.

(10) Goldthwait, J. E.: Backache. New Eng. Jour. Med., 1933, **209,** 722.

(11) Ghormley, R. K.: Low-back Pain, with Special Reference to the Articular Facets. Jour. Am. Med. Assn., 1933, **101,** 1773.

(12) Stimson, B. B., and Sivenson, P. C.: Unilateral Subluxation of the Cervical Vertebræ without Associated Fracture. Jour. Am. Med. Assn., 1935, **104,** 1578.

(13) Gunther, L., and Kerr, W. J.: Radicular Syndrome in Hypertrophic Osteo-arthritis of the Spine. Arch. Int. Med., 1929, **43,** 212.

EDITORIAL

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NEXT ANNUAL MEETING

DEC. 2–6, HOTEL STATLER, DETROIT

This is the time when members and friends of the Radiological Society of North America are making plans to attend the Annual Meeting, and for that reason it has seemed fitting to say a little about the city of Detroit, this year's meeting place. The modern city is intimately known to many, but a brief résumé of the colorful history may be of interest—how many of us who think of Detroit as the automobile capital of America have ever stopped to think of the reason why a settlement was first located on that site or the trading center which antedated the automotive industry.

The building of Detroit on a spot where Nature has fashioned something splendid was partly out of circumstance, partly out of necessity, and partly because of a very localized convenience. When Cadillac moved across Lake Erie and swung north up the Detroit River he saw the calm blue of these northern waters sheltered from the fury of the Great Lakes by an island at each end, and on the west bank of the river he noticed a slight promontory, overlooking the surrounding country, an ideal spot for his sentinels to watch the movements of the Indians and the British who were gradually encroaching upon the territories of New France and threatening to annihilate the power of France in America.

He built a rude settlement on the rim of this northern wilderness, a savage outpost touched feebly by the stray glints of French chivalry and nobility, holding in its feeble fist the touchstone of the power of the Bourbon dynasty. And the little settlement shambled along the banks of the river, slowly and bravely, anxious about Indian outbreaks and massacres. Through the bleak winters it staggered as hungry as a ghost, ill supplied and out of the reaches of civilization.

Then one day General Wolfe swept the Plains of Abraham, conquered the French with a superior force, and all the lands of the St. Lawrence, Ohio, and Mississippi Valleys were surrendered to Great Britain. The power of France was broken in North America. Detroit became a British possession. It remained so until 1783, when America broke with England. It has since remained under American rule with the exception of a short period during the War of 1812 when the British flag flung its defiance out across her battlements.

The nineteenth century gave birth to a culture that still clings traditionally to the city—a culture that was ripe and glowing before the automobile swept in upon us and our industry in its maddened pace. The middle of the nineteenth century saw a slow and continued growth, a sound healthy condition of business pioneered by men who loved business and its gifts to civilization, men satisfied with small profits but sound financial policy. It is a simple story—how these men rose to wealth and affluence with the success of their business, how they found time, in their slow deliberate pace, to set up a distinct culture, in a society that was born out of savage manners and polished by the glint of the courts of France.

Jefferson Avenue was at one time Detroit's Riviera, colored with fashion, glowing with French manners, styled with aristocracy. Such names as Antoine, Beaubien, Chene, St. Aubin, and Joseph Campau are woven in the familiar scene of old Detroit. Like the ivy clinging to the ancient ruin, Jefferson Avenue refuses to surrender its fascinating character to a mere memory and clings to the early romance of this city. Former wealth paraded here on foot, now it whizzes by in limousines, without a thought, no doubt, of the former gay splendor that feasted here.

Detroit was almost destined to be erased from the business picture of the country. The city was polishing her manners. It was growing, but slowly. People here were more interested in the quiet luxuries of living than in the

Skyline of Detroit.

tenure of a strictly industrial and business complex and Detroit was advertised as a "city where life is worth living." Meanwhile other cities had become great. Chicago, Philadelphia, New York, Boston, Cleveland, St. Louis, Cincinnati, Baltimore, and the West, all gathering a quick momentum to build gigantic perspectives of business, a growing sense to pile cities in the air and heap our American wealth. This psychology began to grow in the middle of the nineteenth century. It was the beginning of our metropolitan immensities of to-day.

Then something happened at Detroit. Near the end of the nineteenth century, a new era was describing its trajectory in the sky. Some of the first experiments on gasoline engines were being tried. Organizations had been formed and failed. Thousands of dollars were being invested and lost. A group of young men, men of business and vision, just a few, strode into those gargantuan battles of finance and personality and won. Many lost with sick hearts. It was the battle of the mighty—mighty minds, mighty wills, mighty energies.

Steam, electricity, and gasoline fought it out on the streets of the towns and the villages of the country. Gasoline won—and out of the thickets of the nineteenth century came a new civilization—a civilization on wheels. Great men had put it there. The tallow of the night watch had burned low over experiments and ugly words. Machinery became the dominant force, the internal combustion engine its dynamo.

An old civilization was reeling then. Things were changing so rapidly that men were winning fame overnight, the men who were prepared for fame, those who saw the fingers of the times tracing new and strange characters on the wall. Some were caught in the eddying torrent, unable to extricate themselves. Some blundered and foundered. Other blusterous fellows rushed in, were caught in its tentacles and whirled to fortunes. A new world of machinery had hurried down upon mankind and men could see its forces being driven from Detroit to the ends of the earth.

And so Detroit became an industrial city, and after our factories were built, we built schools and colleges, libraries and museums, beautiful theaters and office buildings, parks and boulevards. Some of our theaters are among the largest in the world. Others are unique in their strange barbarian architecture. With the beauty of the city's natural setting in this paradise of waters, visitors will find a wealth of interest. Detroit has cultural and educational phases that are known throughout the world, beautiful school buildings, and one of the most complete educational systems in the country.

Detroit presents to the imagination a succession of panoramas in history and legend. The Detroit City Hall has long been surrounded with the sentiment of tradition. Modern business progress demanded a new structure to replace the old, but sentiment has preserved the glow of its historical associations and the building still stands. One can well imagine the genius of the place gazing out reminiscently over the huge skyscrapers. The present building is one of the spots in the city that has not passed into a sacredly venerated memory. It still traces its shadows at the feet of mighty monarchs of modern business, protected from utilitarian vandalism by the tendrils of a sacred tradition.

Detroit's famous Art Center, showing the Detroit Institute of Arts and the Detroit Public Library

PUBLICITY CHAIRMAN'S PLANS

The twenty-first annual meeting of the Radiological Society of North America will be held in Detroit at the Hotel Statler, December 2 to 6, inclusive. This year is the fortieth anniversary of the discovery of the roentgen ray. The Radiological Society of North America is just one-half that age.

Everything is in readiness for a great meeting. Improved economic conditions forecast a large attendance. The program is the best in years, giving evidence of an efficient and industrious Program Committee and denotes our progress and experience. As each section is arranged under a symposium, papers on allied subjects will be read consecutively—the ideal manner in which to present a program. The essayists have had wide and special experience and are well fitted to present their subjects.

Howard P. Doub, M.D., Chairman of the Committee on General Arrangements, and Lawrence H. Reynolds, M.D., Chairman of the Local Committee on Publicity, have been untiring in our behalf and preliminary reports indicate that our stay in Detroit will be enjoyable and profitable.

The commercial and scientific exhibits will equal, if not surpass, our standard of former years.

The clinics, under the direction of B. H. Orndoff, M.D., will be arranged to be of great value to those attending them.

Our guest speakers will be Chevalier Jackson, M.D., and Charles F. Geschickter, M.D., and one or two European radiologists of prominence.

The Dr. Russell D. Carman Memorial Lecture will be delivered by Arthur C. Christie, M.D., of Washington, D. C.

Matters of special importance will be taken up at the executive sessions, particularly in reference to the constitution and by-laws.

The city of Detroit offers many places of attraction and affords an opportunity to view the great automobile industry. The entire program and the arrangements for good entertainment deserve a large registration.

All arrangements and facilities will be provided for the handling of railroad tickets and train connections. Reduced rates will be obtained for those travelling by railroad. (See information under "Transportation," p. 363 of September issue.)

Make your reservations early and plan to remain for the entire session. Bring the ladies with you—they are always welcome. Special arrangements have been made for entertaining them. Come and take part in one of the best meetings you will ever attend.

Many perplexing problems confront us in a rapidly changing world.

WILLIAM J. CORCORAN, M.D., *Chairman*,
Publicity and Educational Committee

GREENFIELD VILLAGE

How interesting it would be if we could turn back the pages of time and see how our forefathers lived! Realize the simplicity of their daily life! Note the progress through the years!

That, to some extent, can be done in a trip through Henry Ford's Greenfield Village near Detroit. It has become one of the most interesting places to visit on the continent. Many newly-weds now visit Greenfield Village on their honeymoon.

Women, especially, like Greenfield Village, for many of the exhibits are centered about the

early American home. Most of the conventions now meeting in Detroit include on their entertainment program for the ladies a lunch at Dearborn Inn and a trip through Greenfield Village.

Men, too, find the Village interesting, for combined with it is the Edison Institute which graphically illustrates the birth of American inventive genius and the progress of industry.

Few realize the magnitude of the task of gathering the parts that together make a typical American village of long ago. There is nothing like it anywhere else in the world. There are early American homes complete with their antique furniture, spinning wheels, looms, quilting frames and all the other appurtenances of home-making back when "man works from sun to sun, but woman's work is never done" was more than a saying.

Facing the village green stands Clinton Inn, famous hostelry, built in 1830, and an important stop for stage coaches on the Chicago turnpike. Nearby are the village general store, the barber shop, the village blacksmith's forge, and the old grist mill that stood for more than a century on the banks of Stony Creek at Frenchtown, near Monroe, Michigan.

Then there's the wagon works and harness shop, the prim New England church, and the little red school house where Henry Ford, himself, once went to school. Recently, the home of Stephen Collins Foster, author of "Old Black Joe," "Suawnee River" and many other favorites, was uprooted from the center of noisy Pittsburgh and re-erected in the ever-growing village of American memories. Nearby a restored stern-wheel steamboat gently rises and falls with the current of the River Rouge.

So Detroit, the city that put the Nation on wheels and changed the tempo of living, has on its outskirts in Greenfield Village a living page of history, not of battles and conquests, but of the simple lives of our forefathers, their hardships and comforts, their triumphs in art and industry.

If you would turn back the pages of history, plan your trip to Detroit to include a visit to Greenfield Village.

Greenfield Village

ADDITIONAL SYMPOSIA[1]

THORACIC PATHOLOGY

Arranged by HARLAN P. MILLS, M.D., Phoenix, Arizona

1. ERNST A. POHLE, M.D., Ph.D., Professor of Radiology.
   L. W. PAUL, M.D., Assistant Professor of Radiology, and
   W. H. OATWAY, JR., M.D., Assistant in Medicine, University of Wisconsin Medical School, Madison. Routine Roentgen Examinations of the Chest of Patients Admitted to the State of Wisconsin General Hospital during a Three-month Period.
2. LEO G. RIGLER, M.D., University of Minnesota Hospitals, Minneapolis. Atypical Distribution of Pleural Effusions.
3. RAY A. CARTER, M.D., Roentgenologist, Los Angeles County General Hospital, Los Angeles. Pulmonary Mycotic Infections. (Illustrated with lantern slides.)
4. THOMAS R. HEALY, M.D., Boston. Yeast Infection of the Lungs. (Form of title may be changed.)

INTRATHORACIC NEOPLASTIC DISEASES

1. CHARLES F. GESCHICKTER, M.D., Surgical-Pathological Laboratory, Department of Surgery, Johns Hopkins Hospital and University, Baltimore. Intrathoracic Tumors. (Illustrated with lantern slides.)
2. JOHN T. FARRELL, JR., M.D., Assistant Roentgenologist, Jefferson Hospital, Philadelphia. The Responsibility of the Radiologist in the Diagnosis and Treatment of Pulmonary Malignancy.
3. D. E. EHRLICH, B.A., M.D., and H. A. HAUPTMAN, M.D., New York City Cancer Institute, New York. Primary Carcinoma of the Lungs.
4. SAMUEL BROWN, M.D., Assistant Professor of Roentgenology, University of Cincinnati, and
   JUSTIN E. MCCARTHY, M.D., Good Samaritan Hospital, Cincinnati. Intrathoracic Tumors: Their Diagnosis and Treatment.

[1] These are in addition to the announcements of symposia published in RADIOLOGY, for September, 1935.

Ford River Rouge Plant

A CORRECTION

In the August issue, page 240, in the review of "Clinical Pathology of the Jaws, with a Histologic and Roentgen Study of Practical Cases," the author's name should read as follows: "By Kurt H. Thoma, D.M.D., Charles A. Brackett Professor of Oral Pathology," etc. Apology is herewith offered to the author and publisher of the work for an inadvertent error.

LIST OF DETROIT HOTELS

Hotel	No. of Rooms	SINGLE With Bath	SINGLE Without Bath	DOUBLE With Bath	DOUBLE Without Bath	TWIN BEDDED With Bath	TWIN BEDDED Without Bath
Abington 700 Seward	135 Suites, $50 up monthly	$2.50 up		$3.50 up			
Belcrest 5440 Cass	135 Suites, $50.00 up monthly	$2.50 up		$4.00 up			
Book-Cadillac Washington Blvd.	1200	$3.00 up		$4.50 up		$5.00 up	
Briggs 114 W. Adams	200	$2.00 up		$3.00 up		$4.00 up	
Dearborn Inn Dearborn, Mich.	100	$3.00 up		$5.00 up		$6.00 up	
Detroit Leland Cass at Bagley	800	$2.50 up		$3.50 up		$4.50 up	
Fort Shelby Lafayette at First	900	$2.00 up	$1.50 up	$3.00 up		$4.00 up	
Lexington 2970 W. Grand Blvd.	100	$2.00 up	$1.25 up	$3.00 up	$2.00 up	$3.00 up	
Madison Lenox Madison and John R.	300	$2.00 up	$1.25 up	$2.50 up	$2.00 up		
Norton Jefferson and Griswold	250	$1.50 up	$1.25 up	$2.50 up	$2.00 up		
Norton Palmer Windsor, Ontario	200 Suites, $6.00 to $8.00 daily	$2.50 up	$1.50 up	$3.50 up	$3.00 up		
Palmetto John R. and Hancock	331	$2.50 up		$4.00 up		$4.00 up	
Seward 59 Seward Ave.	561 Suites, $50.00 up monthly	$2.50 up		$3.50 up			
Statler Grand Circus Park	1000	$2.50 up		$4.50 up		$5.00 up	
Tuller Hotel Park and Adams	800	$2.00 up		$3.50 up			
Wardell Kirby at Woodward	627 Suites, $65.00 up monthly	$3.00 up		$4.00 up		$4.00 up	
Webster Hall 111 Putnam	800	$2.00 up	$1.25 up	$3.00 up	$2.00 up	$3.00 up	
Whittier 400 Burns Drive	816 Suites, $65.00 up monthly	$3.00 up		$5.00 up		$5.00 up	

BOOK REVIEWS

DIE THEORETISCHEN GRUNDLAGEN UND MÖGLICHKEITEN DER RÖNTGENDIAGNOSTISCHEN WEICHTEILUNTERSUCHUNG (The Theoretical Foundations and Possibilities of Roentgen Diagnostic Studies of Soft Tissue). By ADOLF ZUPPINGER, Assistant, Röntgeninstitut der Universität, Zürich. A volume of 99 pages, with 46 illustrations. Georg Thieme, Leipzig, 1935. Price, M. 16, geb. M. 18.

Good roentgenograms of soft tissue require a very accurate technic since the differences in absorption between the various elements involved are quite small. So far the procedure has been more or less empirical and here is where the investigations of Zuppinger create an entirely new basis. By studying from a physical standpoint the characteristics of films, intensifying screens, spectra of the radiation used in radiography, the qualitative and quantitative changes of the rays after passing through tissues, and the ways and means to overcome certain shortcomings, he arrives at definite deductions regarding the optimal exposure technic. One important phase of his work concerns the efficacy of contrast media. It appears that iodine is the least efficient, with thorium topping the list and silver and bismuth running close seconds. Selenium seems to be the best filter material for radiographic purposes. One table in this monograph shows the absorption coefficients of the various tissues as well as of the most common foreign bodies. The special exposure technic for demonstrating varicose veins in the esophagus, the visualization of the hypopharynx, including the use of a contrast medium, and the radiographic demonstration of the epipharynx are described in detail. A number of excellent illustrations are used throughout the text.

This monograph by Zuppinger fills an urgent need in the radiographic literature. While only a few points can be mentioned in a brief review, an attempt has been made to give at least some idea of the wealth of accurate information offered by the author. The book is heartily recommended, therefore, to the radiologist who understands scientific German and it is hoped that an English translation will be made available soon.

APPARATUS AND TECHNIC FOR ROENTGENOGRAPHY OF THE CHEST. By CHARLES WEYL and S. REID WARREN, JR., Moore School of Electrical Engineering, University of Pennsylvania. A volume of 175 pages and 35 illustrations. Charles C. Thomas, Springfield, Ill., 1935. Price, $5.00.

The publication of this book may well be said to signify the coming of age of roentgen diagnosis. That the latter has assumed sufficient importance in modern medical practice to necessitate a monograph on the technic of one small phase of roentgenology should be a source of gratification to all those who are laboring in this field.

It is fitting that a book on the technic of chest roentgenography should be issued from Philadelphia (it is a product of the Moore School of Electrical Engineering of the University of Pennsylvania), where the work of McPhedran, Pancoast, and Pendergrass, and numerous others, has done so much to make the roentgen diagnosis of lung diseases possible.

This small volume covers the entire field of roentgen diagnostic technic, as related to the chest, from the proper installation of the electrical supply and the choice of transformer to the construction of the viewing box. These technical details are considered from the point of view of the fundamental physical principles underlying them rather than from the practical technical standpoint. The numerous experiments undertaken by the authors to establish these principles are described in comprehensive form. Nevertheless, there is considerable attention to the practical details of the production of a roentgenogram. Certain important data such as the positioning of the patient or the centering of the tube are not given—possibly because they appeared to be too obvious. On the whole, however, few details are overlooked, and there are some quotations from the literature, particularly as to the work of R. B. Wilsey.

The book presents a valuable guide to the fundamental principles involved in all x-ray diagnostic technics. In certain portions the material may appear rudimentary to the practising roentgenologist. Many of the details are well known. Nevertheless, it is well to have them presented as clearly and concisely as is here done.

A few concrete illustrations may serve to indicate the scope of the material presented.

The authors wisely caution against the use of very low voltages in chest roentgenography. They call attention to the discrepancy between the milliampere-seconds and the degree of exposure when widely variable exposure times are used. They agree with Wilsey that an exposure time of $^1/_{10}$ to $^1/_{30}$ of a second is the most advisable under present conditions. There is a short criticism of the use of x-ray paper and of portable x-ray machines of insufficient power in tuberculosis surveys. Numerous exactly detailed methods are described for testing screens, cassettes, films, dark room equipment, tubes, etc. While most of these are familiar to the experienced roentgenologist, it is valuable to have them set down so that they can be referred to upon occasion. The book is thoroughly recommended.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J. N. Ané, M.D., of New Orleans, La.
S. M. Atkins, M.D., of Waterbury, Conn.
G. E. Burch, Jr., M.D., of New Orleans, La.
Hans W. Hefke, M.D., of Milwaukee, Wis.
H. A. Jarre, M.D., of Detroit, Mich.
Davis H. Pardoll, M.D., Chicago, Ill.
E. A. Pohle, M.D., Ph.D., of Madison, Wis.

CONTENTS OF ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

BIOLOGIC EFFECTS OF RADIATION

High Speed Electrons and Their Significance in Radiation Therapy. R. Glocker. Strahlentherapie, 1935, **53,** 417–423.

The author studied the effect of high speed electrons produced in a specially constructed tube at 1.6 million volts on the eggs of *Drosophila*. It appeared that the percentage depth dose in a certain depth was higher than the surface dose; in the extreme case as much higher as 50 per cent. This is in contrast to roentgen rays in which the dose in the depth is lower than the surface dose.

Glocker describes briefly an apparatus which is under construction and will be used in clinical tests for superficial therapy; it is supposed to operate at 2.5 million volts. He believes that the therapeutic use of high speed electrons is the method of the future and that the necessary equipment with potentials up to 20 million volts will soon be available.

ERNST A. POHLE, M.D., Ph.D.

Radiation Genetic Experiments Dealing with the Time Factor on the Fruit Fly. N. W. Timoféeff-Ressovsky and K. G. Zimmer. Strahlentherapie, 1935, **53,** 134–138.

The authors studied the effect of the time factor on the rate of mutation in the fruit fly. They varied the intensity in the ratio of 1 : 300, and the total time of irradiation in the ratio of 1 : 1,440. In both cases the exposure of 3,000 r produced identical rates of mutation. It is concluded, therefore, that the order of magnitude of the dose controls the rate of mutation and not the time factor.

ERNST A. POHLE, M.D. Ph.D.

BONE DISEASES (DIAGNOSIS)

Multiple Spontaneous Idiopathic Symmetrical Fractures. Louis A. Milkman. Am. Jour. Roentgenol. and Rad. Ther., November, 1934, **32,** 622–634.

The author reports a case, followed over an eight-year period, with postmortem findings, that he believes is a new skeletal disease which is progressive and may be fatal. The characteristics of this disease are the disturbance in gait, pains in the back, and involvement of the skeleton.

The characteristic roentgenographic appearance is bands or zones of increased transparency seen throughout the involved bones. They are multiple and symmetrical. The etiology is unknown. The parathyroid glands were not involved. Increased vascularity at the transparent zones was present, suggesting trophic disturbance. The patient was 43 years of age when symptoms began.

S. M. ATKINS, M.D.

Contribution Concerning Osteochondritis Dissecans. P. Kröker. Röntgenpraxis, July, 1935, **7,** 455–460.

Trauma and embolic processes are thought to be the cause for aseptic necroses in the epiphyseal region of several bones. Since Rahm has described a familiar occurrence of osteochondritis in six members of one family, the possibility must be considered that local causes are not the only bases for this disease. Some cases reported by the author seem to show that trauma is not necessarily an etiologic factor, but that there must be a congenital inferiority of the skeletal system.

HANS W. HEFKE, M.D.

Osteochondritis. J. F. Brailsford. British Jour. Radiol., February, 1935, **8,** 87–134. (Reprinted by permission from the British Med. Jour., June 8, 1935, p. 93 of Epitome of Current Medical Literature.)

As the result of long-continued investigation of different kinds of osteochondritis, the author claims that they are all local manifestations of the same pathological process, and should no longer be classed as separate entities. Trauma is the most probable cause, but does not produce the condition except in the presence of some other factor at present unknown. Radiographs supply evidence as regards the nature of the bone changes, the stage and possibly the age of the lesion, and the activity of the bone changes. In these conditions the bones become plastic and susceptible to deformity from pressure and strain. The clinical signs and symptoms usually disappear long before the plasticity, and treatment must, therefore, be regulated by the radiographic appearances. Comparison of a series of radiographs taken at intervals during the course of the disease will supply the best evidence, not only for regulating treatment, but also for differentiating such conditions as sepsis, endocrine disorders, and chondro-dystrophies which at one stage produce somewhat similar radiographic appearances.

CALCULI

The Etiology of Urinary Calculus. H. P. Winsbury-White. British Jour. Urol., June, 1935, **7,** 103–115.

To sum up briefly, the author states that the trend of evidence is toward the fact that there are many factors which work in some cases individually and in others collectively to predispose toward urinary lithiasis. Whether these etiologic agents in due course give rise to a common lesion of the urinary tract or merely to changes in the urine, which finally lead to stone, are matters which still require elucidation. In the meantime, the point of practical interest is that both prophylaxis and treatment can be profitably directed toward an endeavor to control known predisposing causes.

DAVIS H. PARDOLL, M.D.

CANCER (DIAGNOSIS)

Distribution of and Fight against Cancer. Hans R. Schinz. Strahlentherapie, 1935, **53,** 363–416.

In an abbreviated article of 53 pages (the complete original appeared in "Schweiz. med. Jahrbuch," 1935, p. 60), the well-known Swiss radiologist discusses very thoroughly the fundamental principles of an intelligent fight against cancer. Backing all his statements with numerous statistical data, he concludes that we must wait patiently until the cause of cancer has been dis-

covered. Until then surgeon and radiologist must cooperate closely in the treatment of malignant tumors. This paper presents so much food for thought that a translation into English and publication at an early date is recommended.

ERNST A. POHLE, M.D., Ph.D.

Serial Bronchography in the Early Diagnosis of Bronchial Carcinoma. Pedro L. Fariñas. Am. Jour. Roentgenol. and Rad. Ther., December, 1934, **32,** 757–762.

In order to make a diagnosis of bronchogenic carcinoma in its early stages, serial bronchography under roentgenoscopic control is very important. The polypoid type shows a filling defect *en face* and a notch in profile. The infiltrating type produces concentric stenosis. The necrotic type produces irregular bronchial cavities with diffuse borders.

When the tumor is located near the large bronchi, it may compress and displace them; when very far away, they displace the bronchioles and the parenchyma.

S. M. ATKINS, M.D.

CANCER (THERAPY)

Some Reflections Regarding Carcinoma of the Uterus, with Special Consideration of the Technic in the Treatment of Infected and Febrile Forms. Angelo Santoro d'Emidio. Strahlentherapie, 1935, **53,** 525–527.

Carcinoma of the fundus, if operable, should go to the surgeon and if inoperable to the radiologist. The author recommends intravaginal radium therapy by means of a pessary containing four radium screens. This permits also the irradiation of the parametria. The cervix is treated by means of a T-applicator containing two screens of 10 mg. each filtered through 2 mm. Pt. In cases with extensive lesions, three screens are used. The irradiation usually takes 11 days. By using a special technic, gauze packs are not required, which is, in the author's opinion, very important. A necrotic cervix is treated by continuous irrigation with Dakin solution. External roentgen therapy is given either before or two months after the radium treatment regardless of whether or not the parametria are involved.

ERNST A. POHLE, M.D. Ph.D.

Treatment of Cancer of the Penis. K. Overhof. Röntgenpraxis, July, 1935, **7,** 468–472.

The Clinic of Holfelder, in Frankfort, reports 22 cases of cancer of the penis treated since 1926. Four cases were operated on and had post-operative irradiation, their average length of life being from three to eight years; four cases were operated on only, their duration of life being from one to five years; eight cases were treated with roentgen rays only, the average length of life being from three to four years; six cases were irradiated and later operated on, the duration of life being from three to eight years. The statistics offered by the author show that roentgen treatment alone offers about the same chance for the patient as surgery, and that post-irradiation surgery may be done without harm when the tumor does not respond well to roentgen therapy. If the cancer of the penis is removed surgically (with resection of the inguinal glands), prophylactic irradiation should always be employed.

HANS W. HEFKE, M.D.

CONTRAST MEDIA

Practical Observations on the Use of Iodized Oil in Bronchography. L. R. Sante. Am. Jour. Roentgenol. and Rad. Ther., December, 1934, **32,** 763–768.

Iodized oil injected into the trachea descends by gravity to the region of the smaller bronchioles only, since the entrapped air in the terminal alveoli serves as a cushion. Viscosity of the oil has no bearing on the ultimate filling. The imprisoned air is then absorbed by the circulating blood and thus the oil reaches the alveoli.

The application of cocaine to the bronchial mucosa defeats its own purpose, since it causes dilatation and allows a much greater amount of oil to collect in the larger bronchial branches, which obscures the finer structures—in the early days of lung study they were mistaken for abscesses.

The oil in the terminal air sacs remains unabsorbed for many months, when it loses its characteristic appearance and may resemble tuberculosis. Owing to the possible fibrosis of the alveoli produced by this long sojourn, it seems advisable to confine the examination to the immediate field under investigation and employ cocainization of the larynx only.

The various methods of injection are mentioned, the most satisfactory being through a catheter, previously inserted into the trachea under local anesthesia, since this permits roentgenoscopic observation during the injection.

S. M. ATKINS, M.D.

Historical and Practical Consideration of Pyelographic Media. A. E. Goldstein and B. S. Abeshouse. Am. Jour. Roentgenol. and Rad. Ther., February, 1935, **33** 165–175. (Reprinted by permission of the British Med. Jour., June 8, 1935, p. 93 of Epitome of Current Medical Literature.)

The authors compare various pyelographic media. They consider that "skiodan" in 15 or 20 per cent strength is the ideal medium for retrograde pyelography, since a clear sharp outline of the upper urinary tract is always obtained, and it is non-toxic, non-irritating, and easy to inject. It may be used for simultaneous bilateral pyelography with no danger of a post-pyelographic reaction due to edema, congestion, or hemorrhage of the urinary mucosa. Emulsified "campiodol" has also proved to be a good pyelographic medium, since its use is almost painless. The only objections to its employment are the difficulty of injecting it through a small ureteral catheter and its relatively high cost. Sodium iodide (13.5 per cent) still retains its usefulness, providing that the injections are made carefully and slowly. Its low cost, easy sterilization, and low viscosity render it popular.

The authors state that the frequent occurrence of unpleasant symptoms, such as pain, burning, and hemorrhage, which follow its use, are due to the irritative and hemolytic action of the drug itself upon the urinary mucosa, even when no undue pressure has been exerted and over-distention has been avoided. Since these untoward reactions may follow unilateral pyelography, its employment in bilateral pyelography is injudicious and dangerous. The fact that patients are frequently compelled to stay overnight in hospitals following a pyelographic study with sodium iodide, thus increasing the cost of the examination, is a further argument against its use.

DOSAGE

Comparison of the Roentgen and Radium Spectrum from the Standpoint of the Practical Radiation Therapist. R. R. Rathbone. Am. Jour. Roentgenol. and Rad. Ther., December, 1934, **32,** 808, 809.

The dose received by the examiner can be minimized if the beam is kept as small as possible during roentgenoscopic examination; as the dose he receives is roughly proportional to the size of the beam used. This was proven by experiments performed with a wax model and ionization chamber measurements.

S. M. Atkins, M.D.

Dosage in Radiation Therapy. R. Paterson British Jour. Radiol., March, 1935, **8,** 155–162. (Reprinted by permission from the British Med. Jour., June 8, 1935, p. 93 of Epitome of Current Medical Literature.)

The three basic physical factors in radiation dosimetry—quantity, quality (wave length), and time—are discussed. In x-ray work skin-dose measurement must include "back-scatter," for the estimation of which the author recommends the phantom method. In radium therapy he thinks that the time has come to give up reckoning in milligram-hours in favor of units of radiation, since no gamma-ray unit has yet received international acceptance, though several have been described. So far in gamma-ray therapy the measurement is made as in air, and factors of absorption and back-scatter have not been considered, but they appear to a large extent to compensate each other. Nevertheless, as higher degrees of accuracy are sought, both these factors will have to be assessed more precisely. The quality in x-ray therapy can be stated in terms of a half value layer—copper, tin, or aluminum all being used—while in radium therapy a sufficient description is given by a statement of the filtration, for the question of the influence of wave length on biological effects is still very open.

An analysis of the relationship of the time factor to dose is, according to Paterson, probably one of the most important needs of radiological investigation. Considerable advantages would be gained if there could be some degree of standardization of the durations of exposure used, particularly in each clinic, by designating routine treatment times and arranging for all treatments to approximate as closely as possible to them. Other problems awaiting elucidation include the explanation of the improved therapeutic results following prolongation of treatment time and the examination of the effects of intermittent exposure. There would appear to be much clinical evidence that the tolerance of tissue to fractionated dosage is greatest if treatment sessions are repeated as frequently as possible, and if each session is as long as possible, entailing the use of an intensity as low as can be economically provided. A certain amount of standardization of interval in relation to any one particular technic would help to yield valuable information.

ENCEPHALOGRAPHY

Technic and Diagnostic Evaluation of Encephalo- and Ventriculograms. B. Schlesinger. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 221–247.

A review of 52 consecutive cases of pneumographic cerebral investigation is presented, the evaluation of these cases being quite comparable to similar American reports. This method of investigation is considered valuable because of its positive and negative findings, the ascertaining of neurologic diagnoses, the furnishing of additional information in a number of cases, the correcting of some diagnoses, and particularly also of eliminating in a number of cases a clinical diagnosis of brain tumor. Such cases are reverted to neurologic diagnoses of, for instance, chronic encephalitis, meningitis, Little's disease, syphilis, arteriosclerosis, brain tubercles, and multiple scleroses.

H. A. Jarre, M.D.

THE ESOPHAGUS

Retrograde (Transgastric) Esophagoscopy for Carcinoma of the Esophagus. G. H. Steele. British Med. Jour., July 13, 1935, **2,** 63.

The author discusses the technic of retrograde transgastric insertion of radon seeds into the lower margin of carcinoma of the esophagus. Two cases in which this procedure was carried out are presented.

A very essential part of the procedure is the use of the gall-bladder rest to raise the lower ribs. Under intratracheal anesthesia, the stomach is delivered through a left paramedian incision. After the application of a gastric clamp, a longitudinal incision about one and a half inches long is made in the anterior surface of the stomach. After the bleeding is controlled by the suture of the edges of the incision, the clamp is removed and applied across the stomach distal to the incision. The stomach contents are then removed by suction. The esophagoscope is then passed through the opening in the stomach and up into the esophagus, keeping the beak of the instrument close to the lesser curvature of the stomach to prevent it from slipping into the fundus. The radon seeds are inserted into the tumor mass by means of a Jobson's trocar and cannula. The esophagoscope is then withdrawn, the incision in the stomach is sutured, and the abdomen closed.

It is believed by the author that, with the use of this method, the combined irradiation of the tumor mass from above and below is preferable to the haphazard irradiation when only the upper edge of the mass is irradiated. Deep x-ray therapy should be employed before the insertion of the radon seeds in order to thoroughly irradiate the peri-esophageal field.

J. N. Ané, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Diseases of the Gall Bladder. Cecil P. G. Wakeley. British Med. Jour., Aug. 10, 1935, **2**, 243–246.

The author discusses the diseases of the gall bladder under the following headings: absence; double gall bladder; torsion; traumatic lesions; cholecystitis, and malignant disease of the gall bladder.

The gall bladder is rarely absent in man. It develops from the primary hepatic diverticulum, and when this outgrowth is bifid, double gall bladder or subdivision of the fundus occurs. This anomaly is rather rare, for Graham was not able to find a single example in 1,218 cases examined by cholecystography. Cave reported two cases which were discovered by means of cholecystography.

During embryonic life, the gall bladder is embedded in the substance of the liver, and this condition may persist throughout life in some individuals. On the other hand, the opposite condition of a freely mobile gall bladder may be found in some cases. In from 4 to 8 per cent of gall bladders, a well formed mesentery is usually found. However, the great majority of these gall bladders are not free because of adhesions to the omentum or the duodenum. It is believed that partial rotation of the organ takes place in most cases, which results in congestion and even inflammation and eventually the formation of adhesions between the gall bladder and surrounding structures. An abnormally long cystic duct likewise predisposes to torsion. Torsion of the gall bladder results in a history of pain in the right abdomen. The surgical treatment of this condition is not so difficult because of the mobility of the gall bladder.

Rupture of the gall bladder with escape of bile into the peritoneal cavity results in acute peritonitis whether organisms are present or not. In the case of gradual escape of bile into the peritoneal cavity, a localized intraperitoneal abscess occurs. Jaundice is noted as the result of the absorption of the bile by the peritoneal cavity. The treatment of this condition is exploratory laparotomy after the initial shock has passed off.

The inflammatory lesions of the gall bladder may be divided into acute and chronic cholecystitis. The author believes that while all perforations of the gall bladder should be operated upon immediately, that in acute cholecystitis conservative surgery should be the treatment of choice. The patient should be observed very closely and conservative measures instituted. If it is noted that the patient's condition does not improve, operation should be performed. In any case it is always advisable to remove the gall bladder after the acute attack of cholecystitis has subsided, and the author considers one month after the disappearance of all symptoms as the useful time to allow before operation.

In the case of chronic cholecystitis, the author believes that the treatment should be complete removal of the gall bladder. While he believes that medical treatment and diet will do a certain amount of good, he does not believe that these forms of therapy can cure the condition or prevent complications. Cholecystography can be of great value in the diagnosis of organic disease of the gall bladder, but it only indicates its power of concentration. A preliminary film should always be made before cholecystography to demonstrate calcified gallstones if these are present.

Carcinoma of the gall bladder is a rare disease but would be even rarer if cases of chronic cholecystitis were submitted to operation. In fully 95 per cent of cases of malignant gall bladders, calculi were found, and in the author's series of ten cases of carcinoma of the gall bladder, calculi were found in every case.

J. N. Ané, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Roentgenkymography of the Duodenal Bulb. S. L. Sorkin. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51**, 35–38.

The author presents the following points:

1. Pyloric opening is produced by gastric systole, closure by gastric peristalsis.
2. Evacuation of the duodenal bulb takes place in two phases, a quick initial systolic emptying followed by a slow concentric contraction of all wall segments.
3. There always remains a small residue in the bulb.
4. Further transportation is accomplished by peristaltic action in the more distal duodenal segments.
5. Frequency of the duodenal bulb is half that of gastric peristalsis and concurrent with each pyloric closure.

H. A. Jarre, M.D.

Unusual Roentgen Observations in "Achylic Chloranemia." R. Pape. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51**, 39–46.

In 1929 the syndrome of "achylic chloranemia" was described by Kaznelson, Reimann, and Weiner. This disease, much resembling pernicious anemia, occurs in women beyond middle age with anemia, weakness, loss of appetite, burning of the tongue, diarrhea, fragility and deformity of the nails, occasionally paresthesias, and rarely funicular symptoms. The color index, in contrast to p.p.a., is reduced. Gastric secretion is reduced and there is in well established cases a complete achylia, not responding to histamine, but with preservation of the anti-p.p.a. principle. The disease develops frequently on the basis of preceding gastric organic disease and following gastric operations. It responds very well to iron therapy.

Three cases of the disease are reported which showed

unusual roentgen symptoms. In one case a diffuse, chronic, hyperplastic gastritis of severe degree was observed. In two patients who had undergone previous gastric surgery, "pseudo-defects" liable to misinterpretations were noted, which are explained as localized, coarse piling-up of mucosal folds in the presence of perigastric adhesions. All three cases gave a history of previous ulcer, present symptoms of occult melena, servere anemia, gastric distress, changes in nails, etc., as mentioned above. "Pseudo-defects" should be differentiated from malignancies by circumscribed, more clear-cut delineation, lack of symptoms of decay, lack of circular involvement, and disappearance on careful palpatory exploration.

H. A. JARRE, M.D.

Roentgenologic Recognition and Evaluation of Intestinal Anastomoses. E. A. Zimmer. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 169–180.

The "end-to-end" anastomosis is superior to the "end-to-side" or the "side-to-side" junction. Resection of part of the sigmoid is advocated in cases of chronic incurable constipation.

Quite a few of the physiologic remarks of this paper are debatable.

H. A. JARRE, M.D.

Congenital Malformation of the Large Bowel. John Alexander Mackenzie. British Med. Jour., July 13, 1935, **2,** 61.

The author reports a case of non-rotation of the colon, in which the only complaint was a dull, dragging pain in the right side. As a child, the patient had had a good deal of diarrhea. The radiologic examination revealed that the barium meal passed from the stomach to the right side of the pelvis. The cecum was found on the left side of the pelvis.

This case is explained embryologically by a study of the normal development of the colon. The fore-gut is supplied by the celiac axis, the mid-gut by the superior mesenteric, and the hind-gut by the inferior mesenteric artery. A physiologic umbilical hernia results because of the increase in the length of the mid-gut. The attachment of the vitelline duct and artery to the apex of the loop produced by the mid-gut divides the mid-gut into a pre-arterial and a post-arterial segment. Rotation begins about the tenth week, and the contents of the hernial sac return in stages. The pre-arterial segment returns to the abdominal cavity first, and passes under the superior mesenteric artery which extends from the aorta to the umbilicus. The cecum is the last segment of the bowel to be returned to the abdominal cavity. It comes to lie in the region of the umbilicus, anterior to the small intestine and superior mesenteric artery. The increase in length of the colon causes the cecum to pass to the right, in front of the small intestine and superior mesenteric artery, and then descends to lie in the ileo-cecal fossa. In the case of non-rotation, the cecum and post-arterial segment return to the abdomen before the pre-arterial segment.

J. N. ANÉ, M.D.

Roentgenkymograms of Gastric Ulcer and Gastric Motor Function. C. Schilling. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 29–35.

A kymographic analysis of normal gastric mobility leads to the consideration of active peristalsis, passive motor phenomena of the proximal gastric segments, and systolic contractions of the entire viscus. In cases of anatomic pathology one can observe, as direct disturbance of function, local arrest of motion and interruption of peristalsis; as indirect symptoms, altered peristalsis and differences in tone and filling of the organ. Various locations of anatomic lesions produce a wide variety in functional disturbances which can be studied to considerable advantage by the use of the kymograph.

H. A. JARRE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

The Value of the Urea-clearance Test in Urinary Surgery. E. W. Riches. British Jour. Surg., July, 1935, **23,** 128–140.

The urea-clearance test is discussed, and the technic employed is described. The results of the test in 109 surgical cases are tabulated. The presence of urinary infection lowers the clearance value. The test is reliable as an index of operability in prostatic obstruction: in cases in which the urea-clearance is over 60 per cent, operation is safe, whilst below this figure it is hazardous.

In unilateral lesions of the upper urinary tract, the total renal function is of little importance; it improves after removal of the underlying cause, and a normal urea-clearance may be attained with only one kidney.

DAVIS H. PARDOLL, M.D.

GENITO-URINARY TRACT (THERAPY)

Necessity for Both Excretory and Retrograde Urography in Certain Cases. Daniel N. Eisendrath. British Jour. Urol., June, 1935, **7,** 124–139.

In three cases, a comparison could be made between the information obtained, respectively, by excretory and ascending (retrograde) urography. In the first case the latter method visualized the right renal calices, showed the size of the hydronephrosis and its probable cause, whereas excretory urography only enabled the diagnosis to be made that a hydronephrosis was present and that there was marked muscular atony. Visualization of the calices in this Case 1 was deemed necessary to exclude tuberculosis.

In the second case, the excretory method visualized the renal pelves on both sides but not the left calices. It yielded valuable information as to the presence of a left hydronephrosis. It failed, however, to be of aid in determining the character of a shadow thought to be

a renal calculus and its position in the kidney. Ascending urography gave all of the missing evidence as to the calculus and a far better conception of the size of the hydronephrosis and of its etiology, as being due to acquired kinking of the ureter.

In the third case, excretory urography failed to show the left hydronephrosis owing to absence of elimination of the opaque medium on this side. Ascending urography enabled the author to detect the presence of a large hydronephrosis due to a ureteral stricture of traumatic origin. The absence of sufficient parenchyma to eliminate the intravenously given opaque medium probably explains why it was not eliminated on the left (hydronephrotic) side, yet gave a good shadow on the normal opposite one.

In the fourth case of multiple infarcts of the kidney (of hematogenous origin in all probability), only excretory urography was employed to ascertain whether or not the patient had an opposite kidney and also to acquire some information as to its function before operation on the right kidney.

Absolute failure to eliminate not only the opaque medium but also indigo-carmine, both given intravenously, can best be explained by a right-sided transitory anuria due to inhibitory nerve influence on renal secretion as the result of the intense hyperemia incidental to the septic infarcts. A similar absence of elimination after excretory urography may be observed in normal kidneys, in those extensively destroyed by disease and in acute ureteral occlusion, as well as in acute hyperemia due to acute renal infection, as in Case 4.

DAVIS H. PARDOLL, M.D.

Epididymal Cysts: Their Etiology and Treatment. E. D'Arcy McCrea. British Jour. Urology, June, 1935, **7,** 152–155.

The author finds that the common epididymal cysts are retention cysts resulting from obstruction. The treatment of choice is by epididymectomy, which completely removes the weak links in the seminal tract.

DAVIS H. PARDOLL, M.D.

Posterior Segmental Block-excision of the Bladder Neck with Primary Closure. S. Harry Harris. British Jour. Surg., July, 1935, **23,** 45–50.

A new operation is described for the treatment of obstructive disease of the bladder neck in which there is no gross enlargement of the prostate. It may be regarded as a companion to the author's operation of suprapubic prostatectomy with closure. It has been carried out 33 times without mortality.

The operation described eliminates the liability to recurrence of obstruction which characterizes cuneiform resection. In addition, the operation is less extensive and safer than complete extirpation of the bladder neck ("ablation totale du col" of Marion) and should ensure results at least comparable with those claimed for this operation.

The diseases for the treatment of which this operation has been designed will often be treated by per-urethral resection, though with what degree of permanence yet remains to be proved.

The type of operation selected should be determined not only by the particular local obstructive condition of the bladder neck but also by the incidence of such complications as stone and diverticulum of the bladder.

The article is accompanied by several reproductions on the technic of this block-excision described by the author.

DAVIS H. PARDOLL, M.D.

GYNECOLOGY

Short Wave Radiation in Rectal and Vaginal Conditions. M. Delherm and Mme. Fainsilber. Rev. d'Actinol. et de Physiothér., March–April, 1935, **11,** 115–125. (Reprinted by permission from British Med. Jour., July 27, 1935, p. 15, Epitome of Current Medical Literature.)

The authors review the possibilities of treatment by short waves of conditions of the rectum and vagina, and record illustrative cases. They have thus successfully cleared up cases of vaginitis, metritis, perimetritis, inflammations of the adnexa, such anal affections as essential fissure, pruritus with ulceration, and sphincter pain associated with hemorrhoids or perianal ulceration. In these painful and sometimes very resistant conditions the intrarectal administration of short wave therapy has resulted in quick amelioration. High frequency currents or diathermy, or the two combined, often act in a similarly prompt and effective fashion; but in the syndromes including sphincter pain a smaller number of sessions are required when short waves are employed. Short wave therapy proved particularly valuable in cutaneous perianal ulcerations and anal pruritus, operating well also in the latter at a distance as well as intrarectally. In some cases reported by the authors associated treatment by cauterizing or sclerosing medication seemed to hasten cure; in others the short wave treatment acted promptly without such measures of reinforcement. The number of sessions required was variable, but it was found that the best and most lasting results were obtainable when the total exceeded eight, and the treatment was continued even after the cessation of symptoms.

HEART AND VASCULAR SYSTEM

The Pulsatory Excursions of the Thoracic Aorta. G. A. Weltz. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 152–169.

It is concluded from kymographic studies that excursions of the *descending* aorta consist chiefly of shifting movements, while there is but little evidence of a peristalsis-like effect, so that the latter can hardly be

detected fluoroscopically. The amplitude of these excursions is increased by high position of the diaphragm, freedom of motion, wide amplitude of blood pressure. It is reduced in cases of sclerosis and marked diffuse aortic widening. There is but little resemblance between the curves of blood pressure and the excursion of the left-sided aorta except that the maximum of both is coincident in time.

Movements of the *right-sided* aorta represent a summation of intrinsically aortic and indirect, transmitted ventricular factors, which cannot be demonstrated individually. Only from a shifting of the curve of the ascending aorta to the left as compared to that of the descending segment can one infer as to the preponderance of aortic or ventricular influences. The latter is magnified by high position of the diaphragm, cardiac enlargements with increased ventricular amplitude, large sub-sternal goiters, elongation and tortuosity of the aorta without widening. It is reduced as a result of small ventricular amplitude and marked aortic widening. The ventricular influence on the ascending aorta is exerted at the end of ventricular filling and during the period of increasing tonus, not during evacuation.

H. A. JARRE, M.D.

The Diagnostic Significance of Kymographically Registered Aortic Pulsations. A. Kahlstorf and E. Ohnesorge. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 22–29.

Kymograms show characteristic differences in the excursion of the aortic wall, especially in the ascending segment, so that aortic insufficiency, mesaortitis luetica, sclerosis, and hypertonia may be differentiated. Extensive thrombosis can at times suppress all pulsation of aneurysms; consequently a differential diagnosis between such and mediastinal tumor may become impossible. Sclerosis and hypertonia, which often show reduced excursion of the walls, also may be confusing. All differences in excursion gradually fade out in the descending aorta.

H. A. JARRE, M.D.

THE LUNGS

Fibrin Bodies in the Pleural Cavity, with Report of Three Cases. Arnold Shamaskin and Jacob Rogoff. Am. Jour. Roentgenol. and Rad. Ther., November, 1934, **32,** 613–616.

Fibrin bodies in the pleural space may be found in cases of hydropneumothorax and become visible when the fluid level drops. These bodies have no significance. They may be free or attached to the pleural surface. Usually they disappear but may persist and eventually calcify. Their average size is that of an English walnut and they usually present a homogeneous density with a smooth sharp outline. Their only importance is the danger of confusion with neoplasm, encysted empyema, exostosis of a rib, and foreign body.

S. M. ATKINS, M.D.

Studies of the Value of Fluoroscopic Examination of the Lungs. Wolf Voigtländer. Röntgenpraxis, July, 1935, **7,** 433–439.

Quite a few studies have been undertaken to determine the comparative value of film and fluoroscopy for the diagnosis of tuberculosis of the lungs. Each type of examination has advantages and both of them should be used. If fluoroscopy alone is used, about 20 per cent of the positive cases will not be recognized, especially the disseminated small nodular type, apical processes, and small infiltrates (Redeker, Braeuning, Engelhardt, and others).

One hundred and eighteen patients with tuberculosis were examined fluoroscopically by the author, who had neither examined the patients clinically nor seen their roentgenograms; of these, 67.8 per cent were diagnosed correctly by the fluoroscopic examination; in 32.2 per cent the fluoroscopy did not give a correct diagnosis. The result of the fluoroscopic observation was afterward compared with films. These 32 per cent of incorrect or insufficient diagnoses prove that fluoroscopy alone cannot be considered a reliable diagnostic means for examination of the lungs.

HANS W. HEFKE, M.D.

A Contribution to the Roentgenologic Demonstration of Emphysema of the Lungs. A. Anthony and W. Schwarz. Röntgenpraxis, July, 1935, **7,** 461–463.

For the roentgenologic demonstration of emphysema the authors have used roentgenograms in inspiration and expiration. While normally there is a definite difference between the two roentgenograms, consisting of lessening in the size of the thorax, elevation of the diaphragms, change in position and size of the heart, disappearance of the lower portion of the heart into the shadow of the diaphragms and increase of the lung markings, seen on expiration, patients with emphysema show an entirely different picture. Most of the above changes were either not present at all in the authors' cases, or very slight. Although this method cannot be very accurate it allows a visual demonstration of emphysema of the lungs.

HANS W. HEFKE, M.D.

The Roentgen Appearance of the Lobulus Accessorius. J. S. Bejlin. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1935, **51,** 47–61.

The lobulus accessorius or infracardiacus, known since Rectorzik, in 1861, and described in detail by Schaffner and Muller, forms a pyramidal pulmonary segment on the basal-medial area of the normal lower lobes. Its occurrence is not as rare as usually assumed, though statistical data vary widely, as do also its size and configuration. Localized acute and chronic infections in this lobe render its roentgen recognition relatively easy. Chronic lobitis, at times with bronchiec-

tases, is at times responsible for so-called triangular basal and paramediastinal shadows.

H. A. JARRE, M.D.

NERVOUS SYSTEM

Possible Effects of Roentgen and Radium Rays on the Vegetative Nervous System. M. Nemenow. Strahlentherapie, 1935, **53,** 473–491.

The author analyzes the mechanism of the various effects observed following roentgen exposure of the autonomic nervous system. The fact that the HCl content of the stomach, its tonus and peristalsis, as well as the blood sugar may be increased or decreased following irradiation can be explained by the assumption that the nerves in a state of higher excitability respond to irradiation. This means that in one case the accelerated fibers will be affected and in the other case the inhibitive fibers. A few patients with stomach ulcer are discussed, who showed remarkable improvement following roentgen therapy. Roentgenograms of the stomach before and after treatment are appended. Experimentally the author could also demonstrate a definite influence of irradiation of the medulla oblongata on the respiration in the decapitated cat.

ERNST A. POHLE, M.D., Ph.D.

The Effect of Roentgen Therapy on the Vegetative Nervous System. Heinz Langer. Strahlentherapie, 1935, **53,** 492–522.

The author explains the effect of roentgen rays in asthma, climacteric disturbances, arthritis, neuralgia, thyrotoxicosis, and vasomotor disturbances by the effect of roentgen rays on an over-stimulated vegetative nervous system. He distinguishes two stages of the reaction following treatment: Stage I of an increased excitability and Stage II of lessened excitability. He also believes that unless these two stages of reaction occur there will be no clinical response. The technic used is described in detail in two articles published in English (Am. Jour. Roentgenal. and Rad. Ther., 1932, **28,** 747, and RADIOLOGY, 1933, **20,** 78).

ERNST A. POHLE, M.D., Ph.D.

NEURALGIA

Radiation Therapy of Neuralgia. A. Zimmern, P. Cottenot, and J. A. Chavany. Strahlentherapie, 1935, **53,** 523, 524.

Roentgen rays applied over the spine (radicular therapy) are most effective in the treatment of neuralgia. In order to insure a high percentage of good results very accurate diagnoses are essential. Technic: 130 kv., 4–5 mm. Al, 150 r per sitting, 5–6 sittings at intervals of two days.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

The Present and Future of Radium Teletherapy. E. R. Carling and F. M. Allchin. Proc. Roy. Soc. Med., June, 1935, **28,** 1145–1156.

Carling, in discussing the problems of radium teletherapy, summarizes the subject from seven points of view: (1) the problem of the construction of a safe apparatus, safety for the personnel; (2) the problem of ascertaining with exact consideration the situation and extent of the tumor; (3) the problem of obtaining a depth intensity and dose of cancericidal order without damage to the skin or intervening and surrounding tissue which resolves itself into (*a*) sufficiency of radium, (*b*) small fields, (*c*) skillful selection of direction; (4) the problem of measuring and recording the dose received by the tumor; (5) the problem of ascertaining the best total dose; (6) the problem of finding measures for increasing differentially the sensitivity of malignant cells; (7) the problem of safeguarding the patient's health.

Carling states that "as against the promised million-volt machine, radium is not entirely at a disadvantage. Initial cost is certainly very great but depreciation is negligible. Upkeep of radium apparatus is quite small. X-ray tubes will, I presume, be very costly. The accommodation required for very large x-ray apparatus will be considerable."

In any case the immediate future calls for: (1) More radium (3 grm. is a necessity, 4 grm. ought to be forthcoming, and much more is desirable); (2) improvements of bomb apparatus; (3) further exploration for means for measuring the dose; (4) accumulation of data as to effective dose in the relation to tumors of different organs and of different histological types; (5) agreement as to grouping of clinical cases—this should be international; (6) more universal co-operation with physicists; (7) transference of control of both forms of apparatus to the same hands—those of the radiologists.

Allchin emphasizes the necessity of developing a radium unit which can be easily measured physically and biologically and of international acceptance. He also emphasizes the necessity for and improvement of apparatus necessary for large quantities of radium.

G. E. BURCH, JR., M.D.